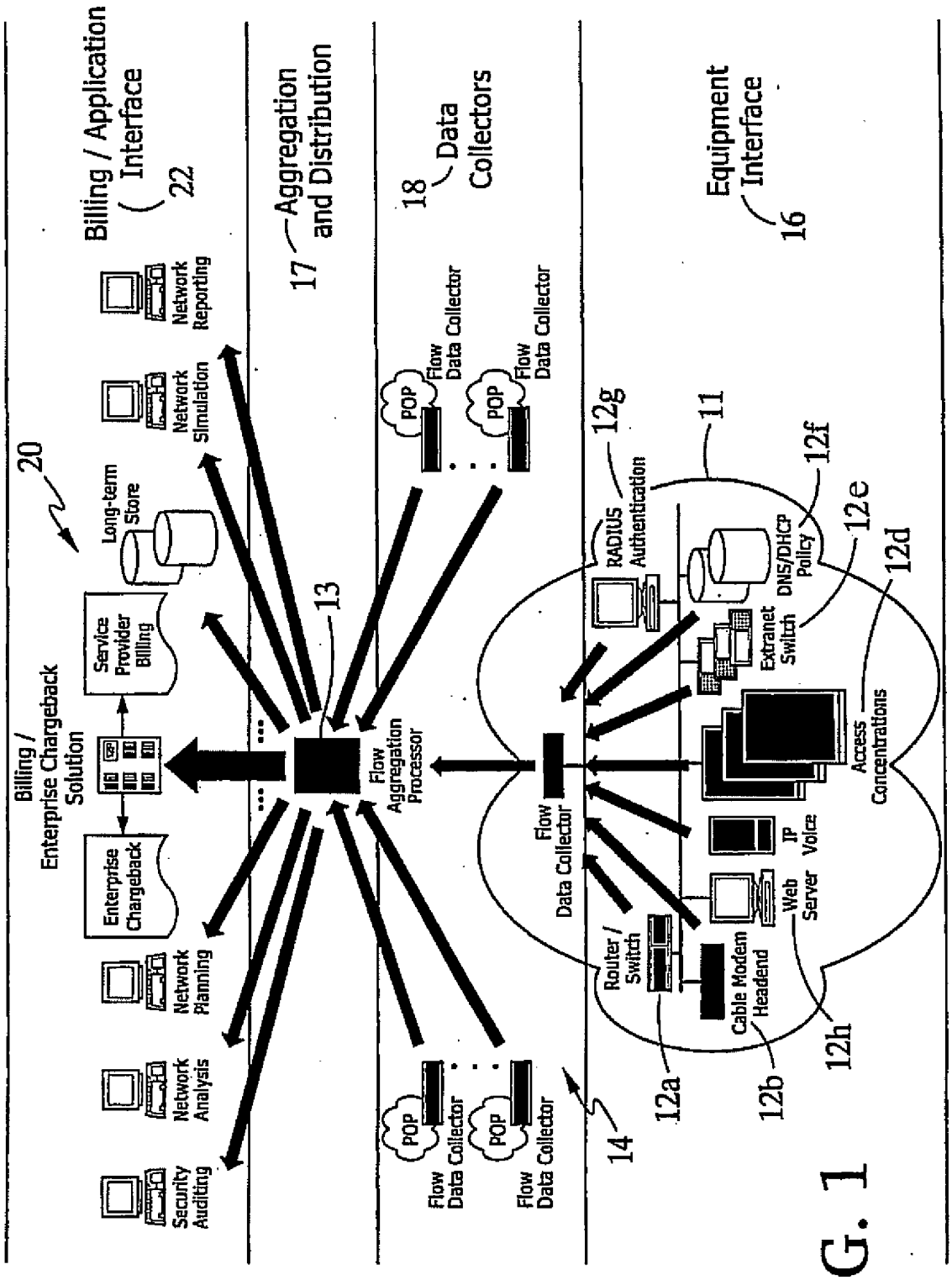
10
Billing / Application Interface
22
Aggregation and Distribution
17
18
Data Collectors
Equipment Interface
16
20
Billing / Enterprise Chargeback Solution
Service Provider Billing
Enterprise Chargeback
Long-term Store
Network Reporting
Network Simulation
Network Planning
Network Analysis
Security Auditing
13
Flow Aggregation Processor
POP
Flow Data Collector
14
11
12g
RADIUS Authentication
12f
DNS/DHCP Policy
12e
Extranet Switch
12d
Access Concentrations
IP Voice
Web Server
Cable Modem Headend
Router / Switch
12a
12b
12h

FIG. 1

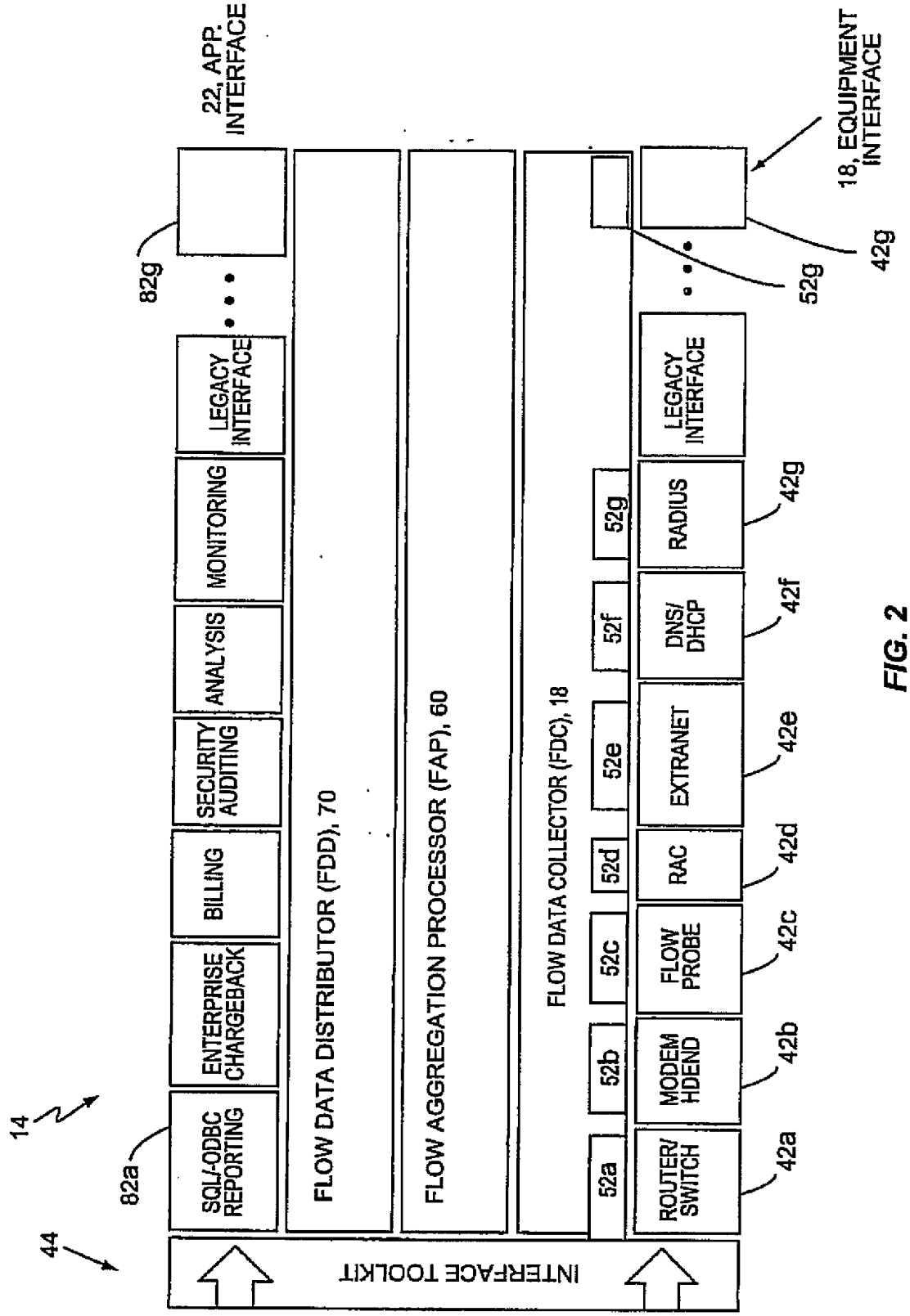
14
44
82a
82g
22, APP. INTERFACE
18, EQUIPMENT INTERFACE
SQL/ODBC REPORTING
ENTERPRISE CHARGEBACK
BILLING
SECURITY AUDITING
ANALYSIS
MONITORING
LEGACY INTERFACE
FLOW DATA DISTRIBUTOR (FDD), 70
FLOW AGGREGATION PROCESSOR (FAP), 60
FLOW DATA COLLECTOR (FDC), 18
52a
52b
52c
52d
52e
52f
52g
ROUTER/ SWITCH
MODEM HDEND
FLOW PROBE
RAC
EXTRANET
DNS/ DHCP
RADIUS
LEGACY INTERFACE
42a
42b
42c
42d
42e
42f
42g
INTERFACE TOOLKIT

FIG. 2

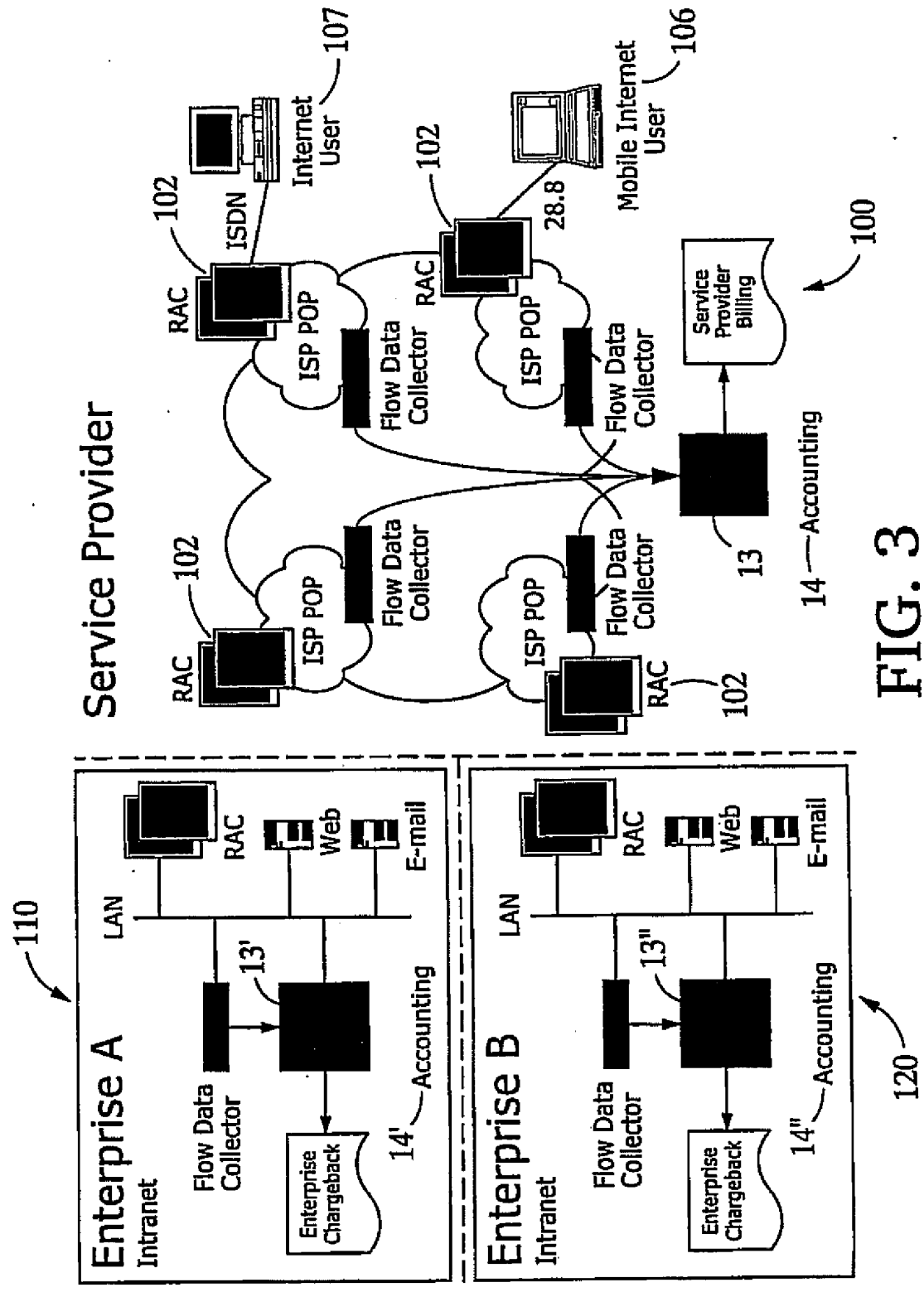
Service Provider
RAC
102
ISDN
Internet User
107
ISP POP
Flow Data Collector
RAC
102
28.8
Mobile Internet User
106
ISP POP
Flow Data Collector
Service Provider Billing
100
RAC
102
ISP POP
Flow Data Collector
ISP POP
Flow Data Collector
RAC
102
13
14 Accounting
110
Enterprise A
Intranet
LAN
RAC
Web
E-mail
13'
Flow Data Collector
Enterprise Chargeback
14' Accounting
Enterprise B
Intranet
LAN
RAC
Web
E-mail
13"
Flow Data Collector
Enterprise Chargeback
14" Accounting
120

FIG. 3

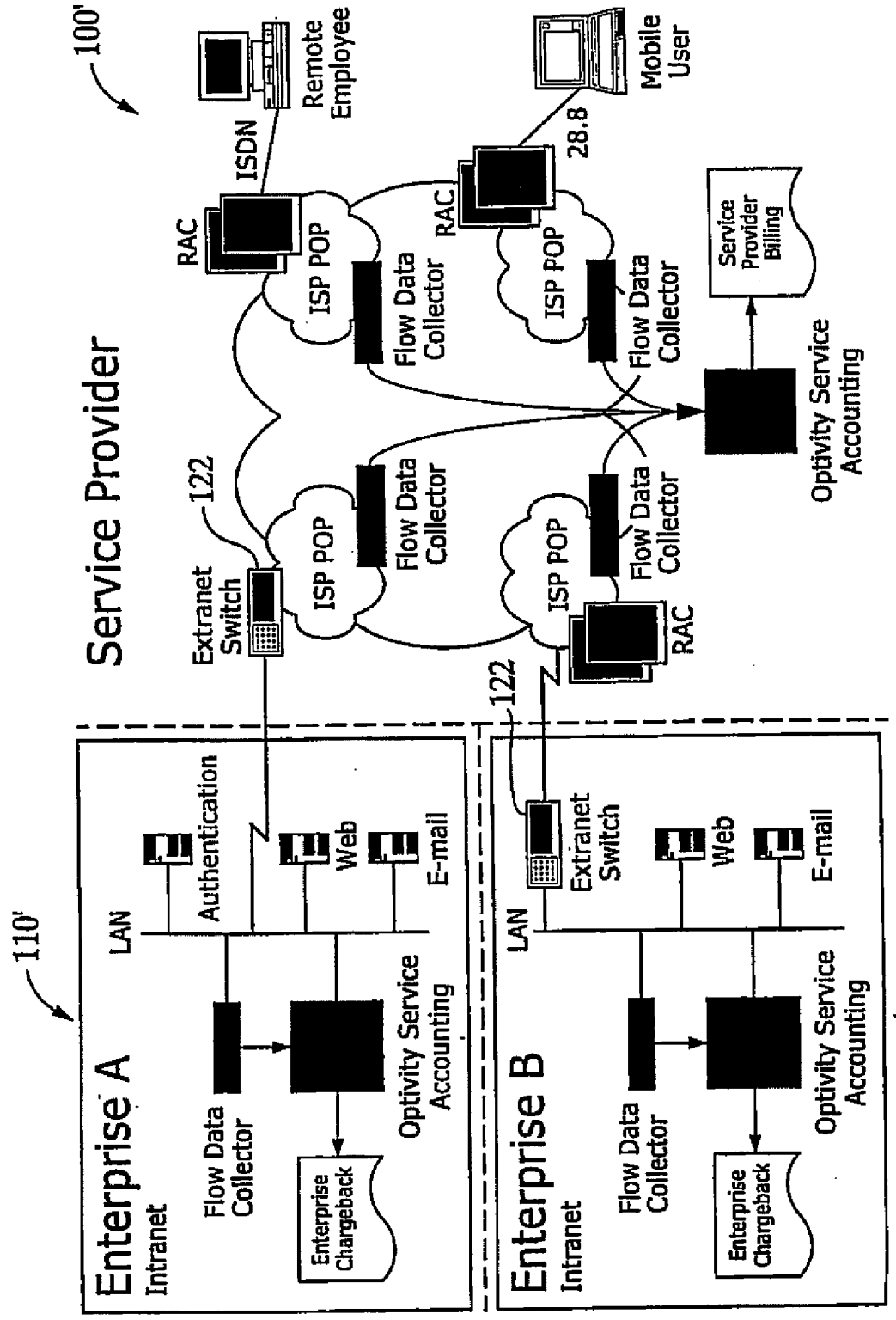
100'
Service Provider
Remote Employee
ISDN
Mobile User
28.8
RAC
RAC
RAC
ISP POP
ISP POP
ISP POP
Flow Data Collector
Flow Data Collector
Flow Data Collector
Flow Data Collector
Service Provider Billing
Optivity Service Accounting
122
122
Extranet Switch
Extranet Switch
110'
Enterprise A
Intranet
LAN
Authentication
Web
E-mail
Flow Data Collector
Optivity Service Accounting
Enterprise Chargeback
Enterprise B
Intranet
LAN
Web
E-mail
Flow Data Collector
Optivity Service Accounting
Enterprise Chargeback
120'

FIG. 4

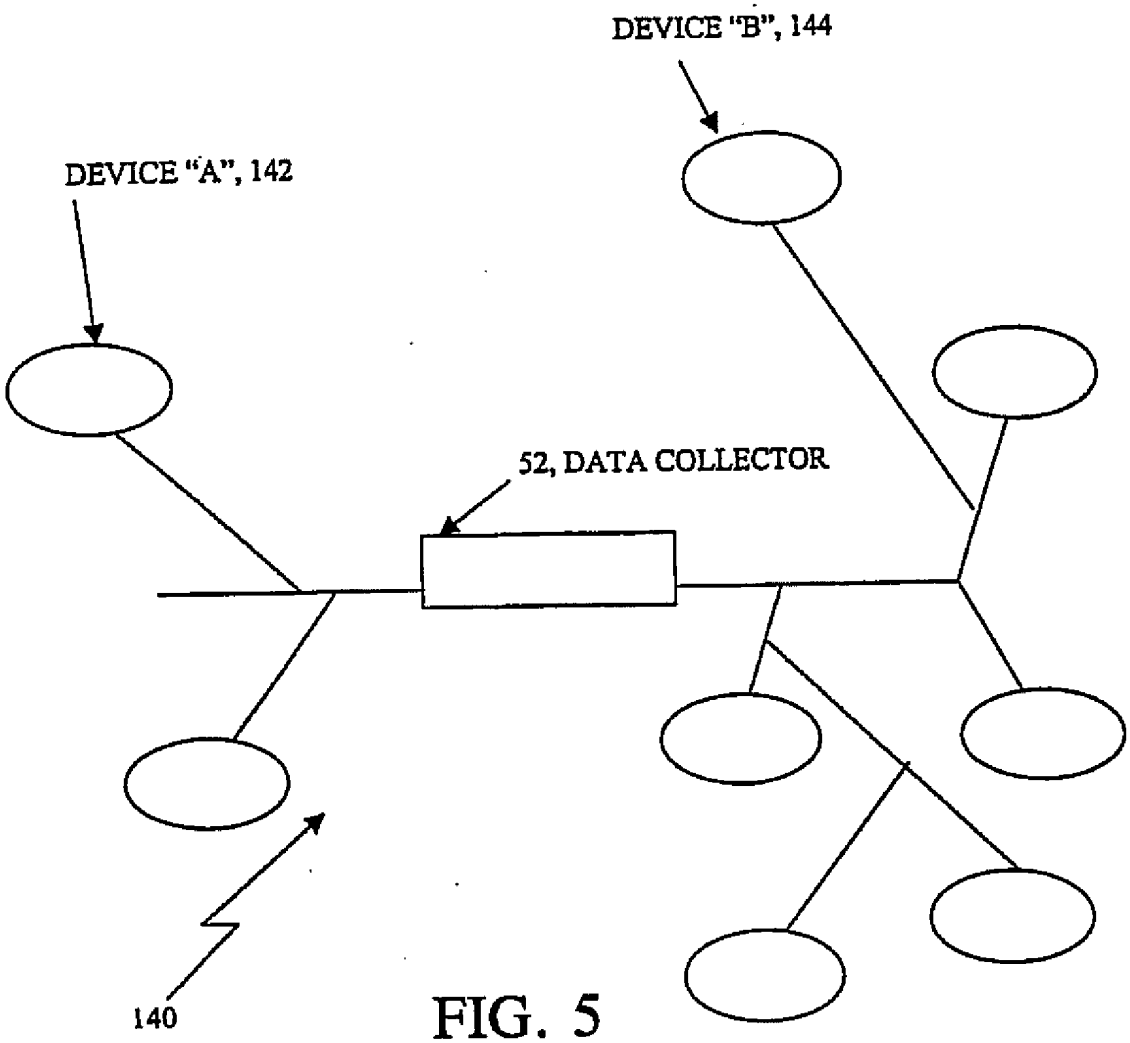

FIG. 5

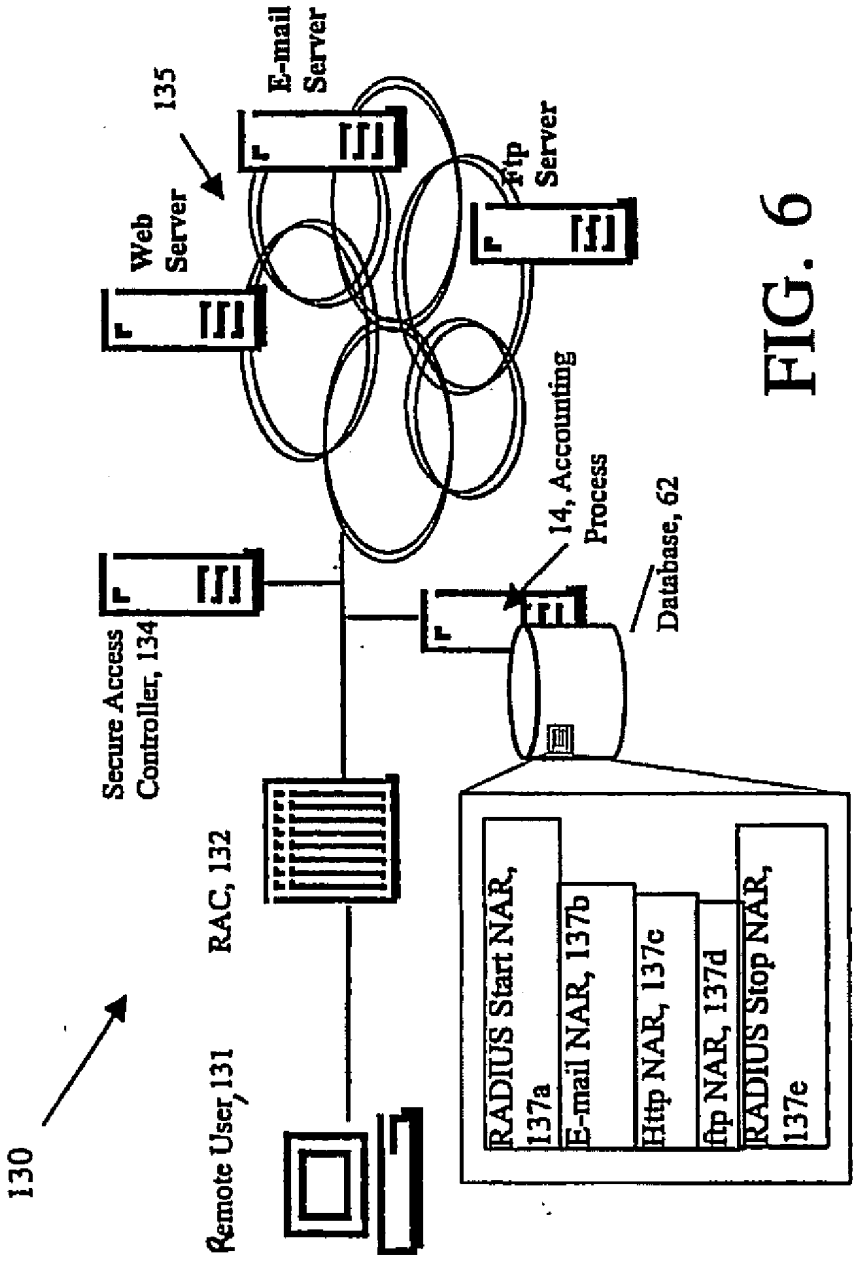
130
Remote User, 131
RAC, 132
Secure Access Controller, 134
Web Server
135
E-mail Server
Ftp Server
14, Accounting Process
Database, 62
RADIUS Start NAR, 137a
E-mail NAR, 137b
Http NAR, 137c
ftp NAR, 137d
RADIUS Stop NAR, 137e

FIG. 6

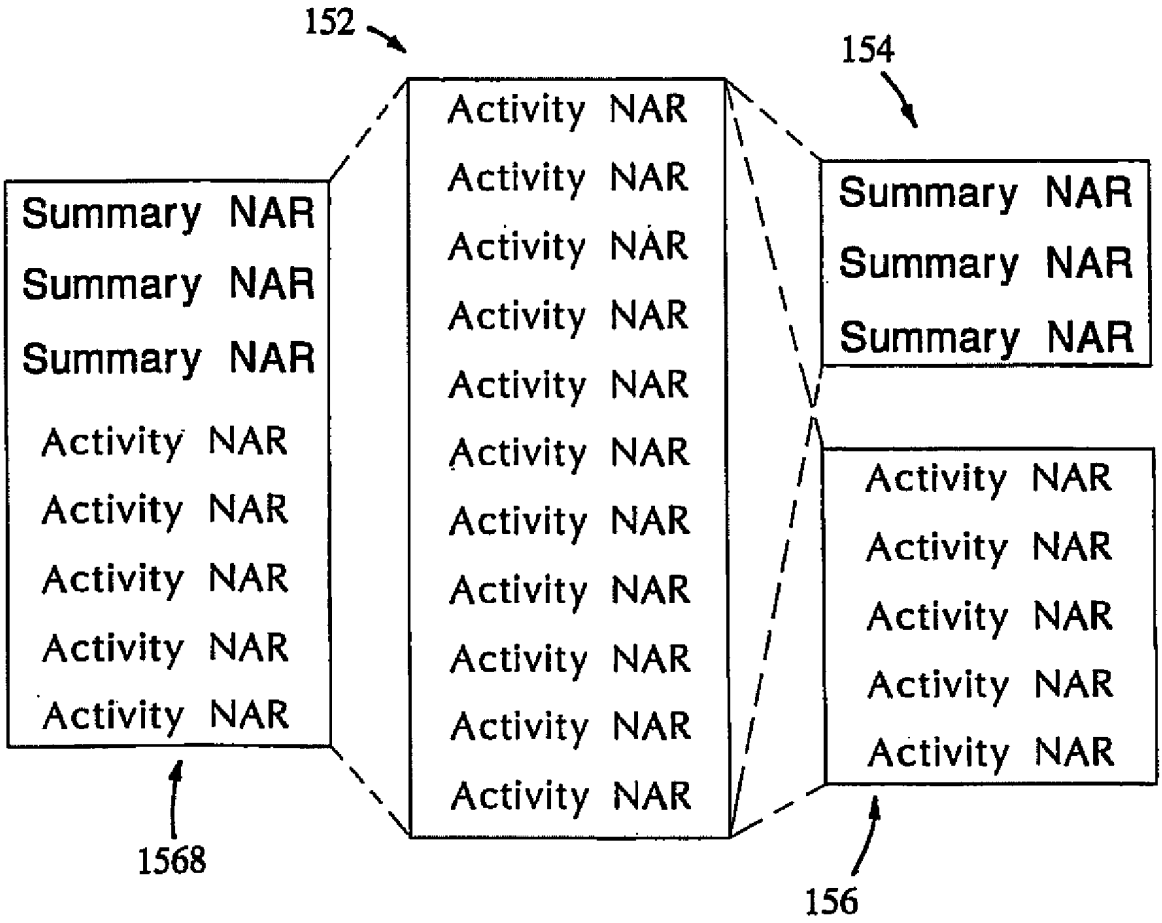
152
154
Summary NAR
Summary NAR
Summary NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
1568
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Summary NAR
Summary NAR
Summary NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
Activity NAR
156

FIG. 7

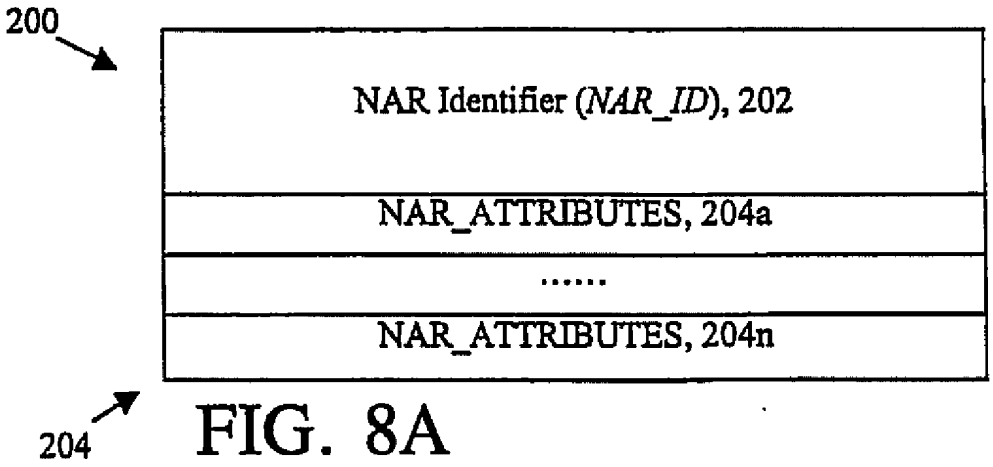
200
NAR Identifier (*NAR_ID*), 202
NAR_ATTRIBUTES, 204a
.....
NAR_ATTRIBUTES, 204n
204

FIG. 8A

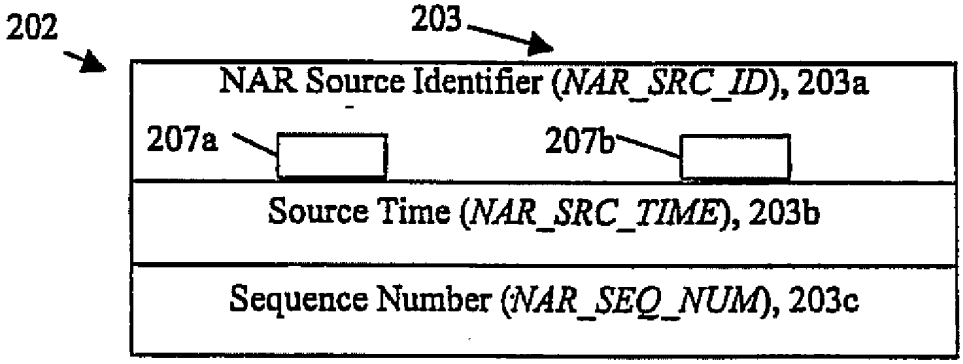
202
203
NAR Source Identifier (*NAR_SRC_ID*), 203a
207a
207b
Source Time (*NAR_SRC_TIME*), 203b
Sequence Number (*NAR_SEQ_NUM*), 203c

FIG. 8B

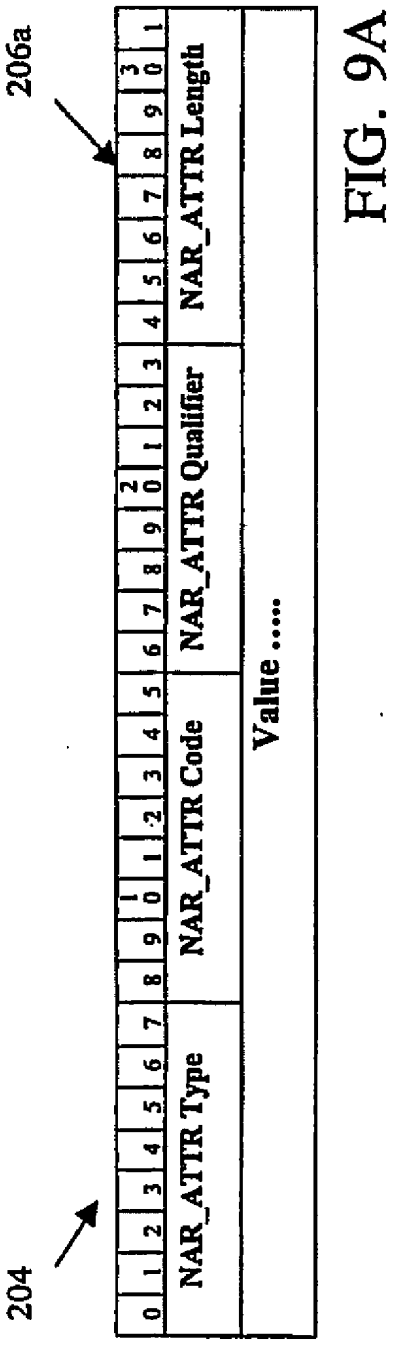
206a
204
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NAR_ATTR Type
NAR_ATTR Code
NAR_ATTR Qualifier
NAR_ATTR Length
Value ....

FIG. 9A

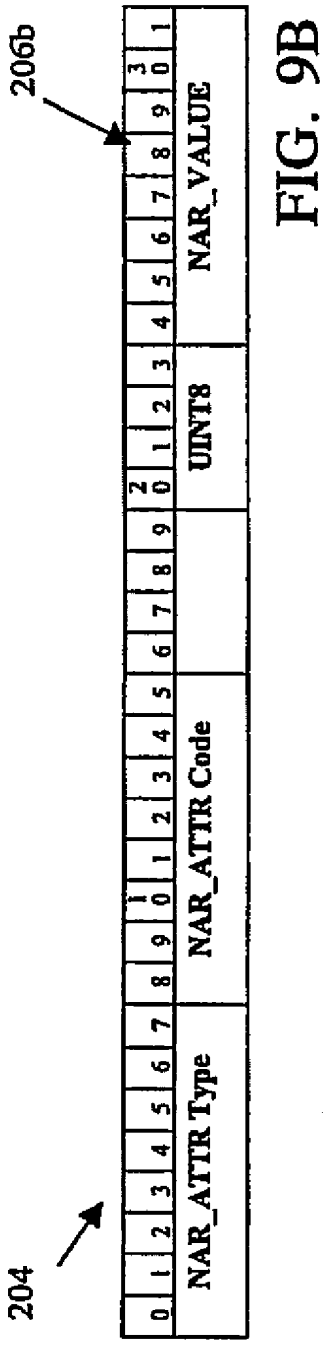
206b
204
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NAR_ATTR Type
NAR_ATTR Code
UINT8
NAR_VALUE

FIG. 9B

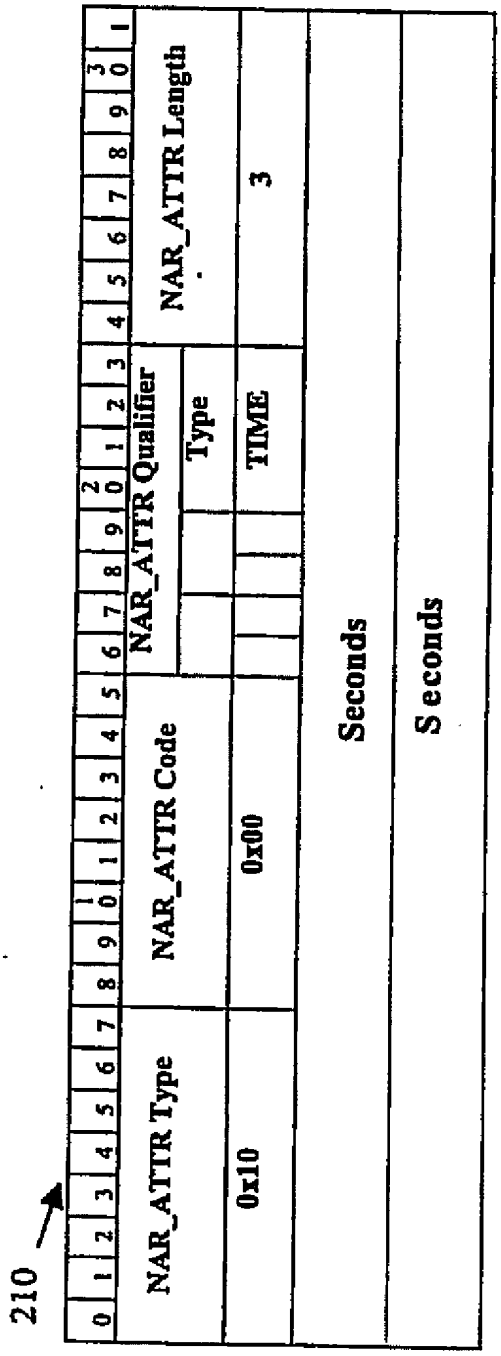
210
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NAR_ATTR Type
NAR_ATTR Code
NAR_ATTR Qualifier
NAR_ATTR Length
0x10
0x00
Type
TIME
3
Seconds
Seconds

FIG. 10

FIG. 11A

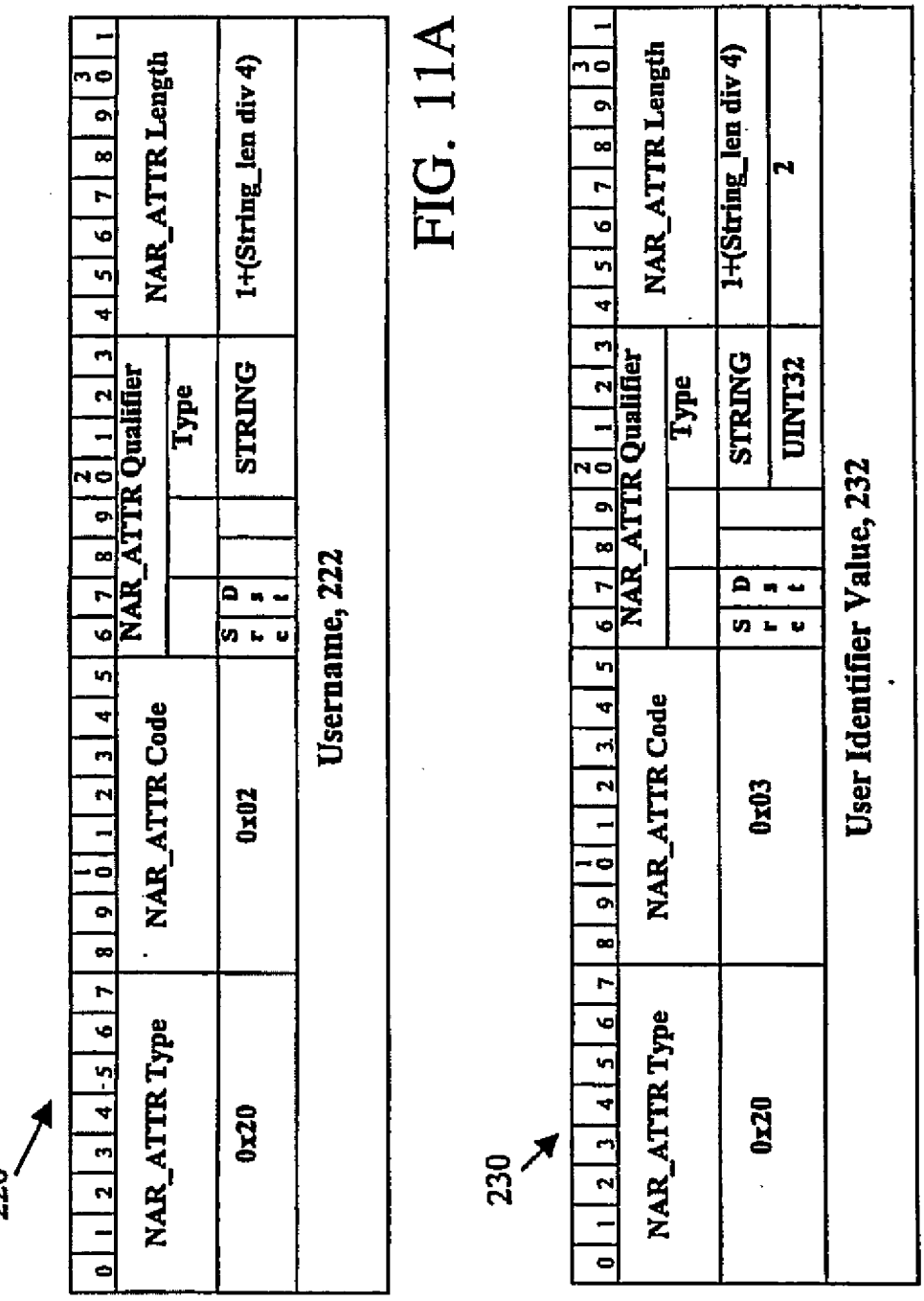

FIG. 11B

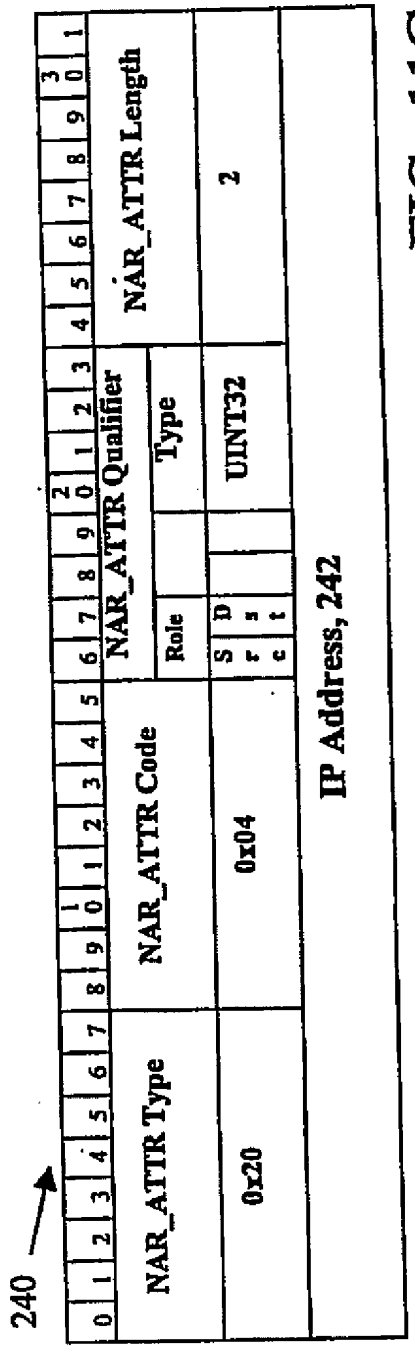

FIG. 11C

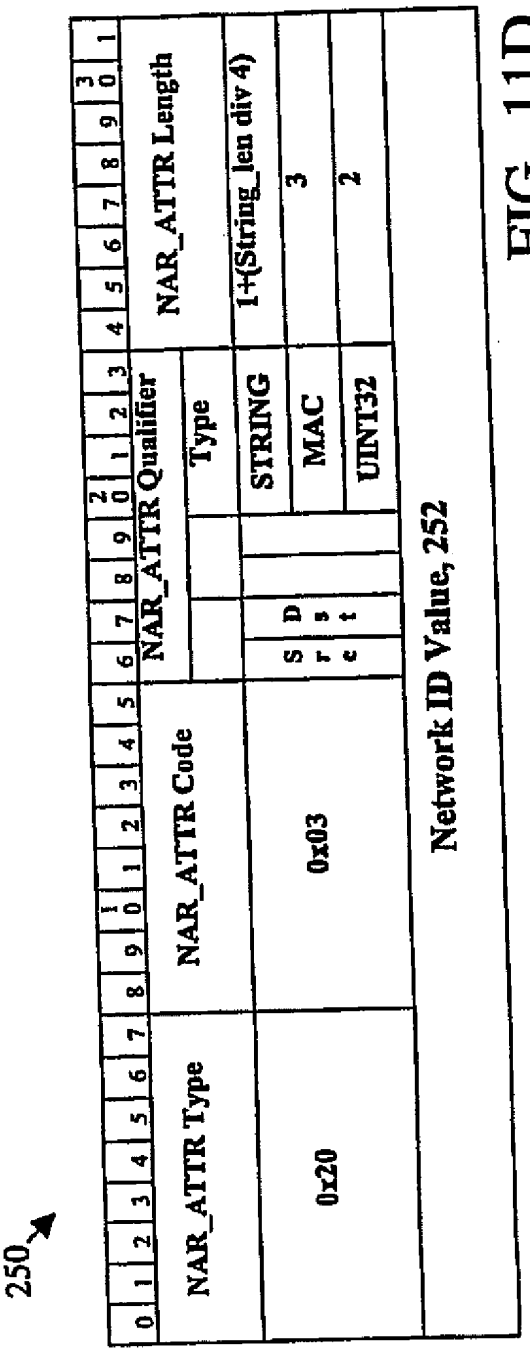

FIG. 11D

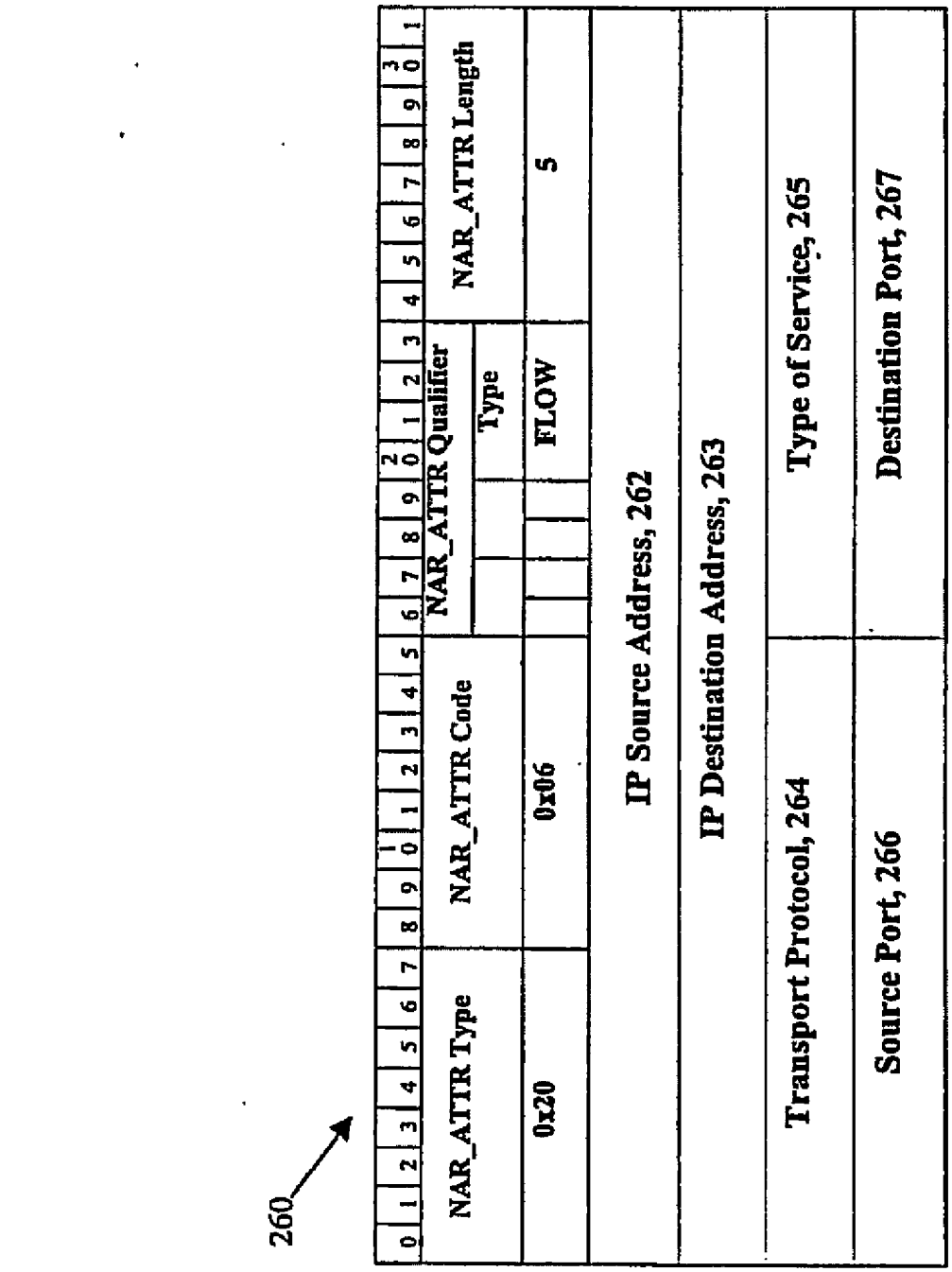
260
0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 20 1 2 3 4 5 6 7 8 9 30 1
NAR_ATTR Type
NAR_ATTR Code
NAR_ATTR Qualifier
Type
NAR_ATTR Length
0x20
0x06
FLOW
5
IP Source Address, 262
IP Destination Address, 263
Transport Protocol, 264
Type of Service, 265
Source Port, 266
Destination Port, 267

FIG. 11E

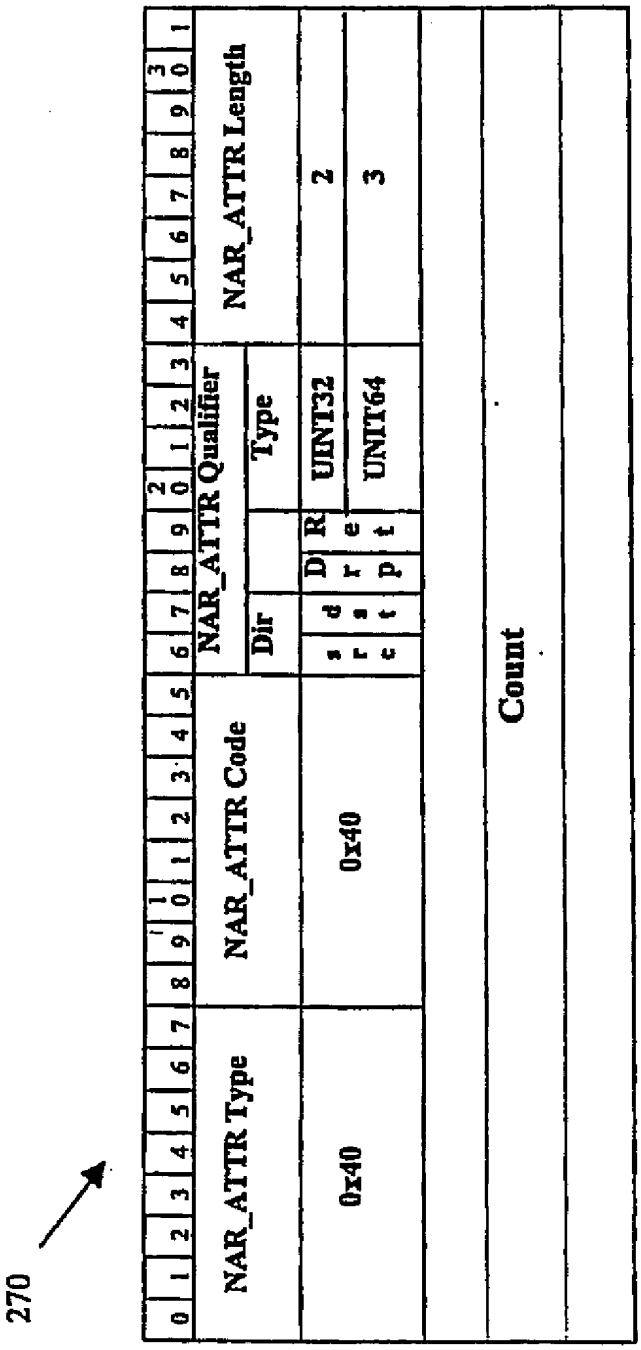
270
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NAR_ATTR Type
NAR_ATTR Code
NAR_ATTR Qualifier
NAR_ATTR Length
0x40
0x40
Dir
Type
UINT32
UINT64
2
3
Count

FIG. 12

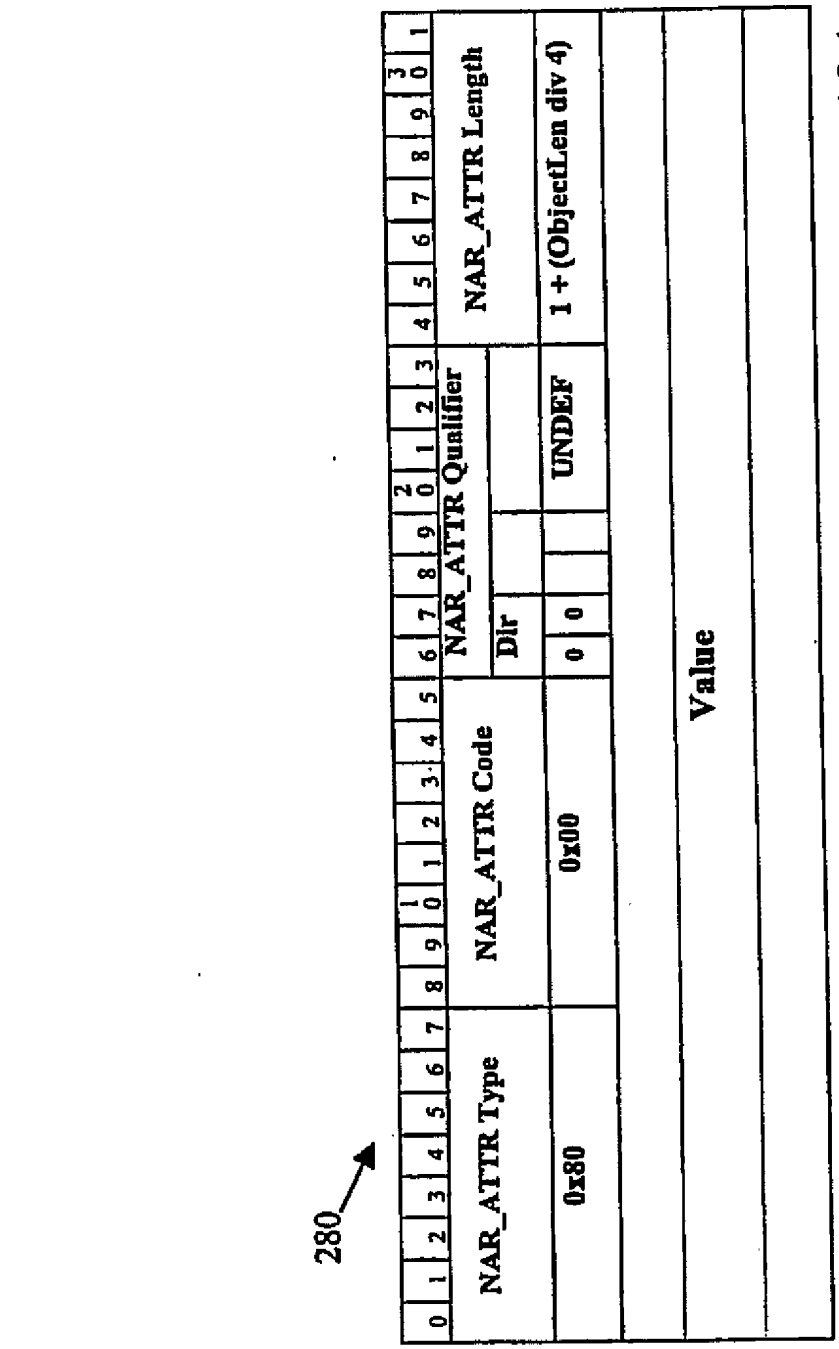
280
0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 20 1 2 3 4 5 6 7 8 9 30 1
NAR_ATTR Type
NAR_ATTR Code
NAR_ATTR Qualifier
NAR_ATTR Length
0x80
0x00
Dir
0 0
UNDEF
1 + (ObjectLen div 4)
Value

FIG. 13A

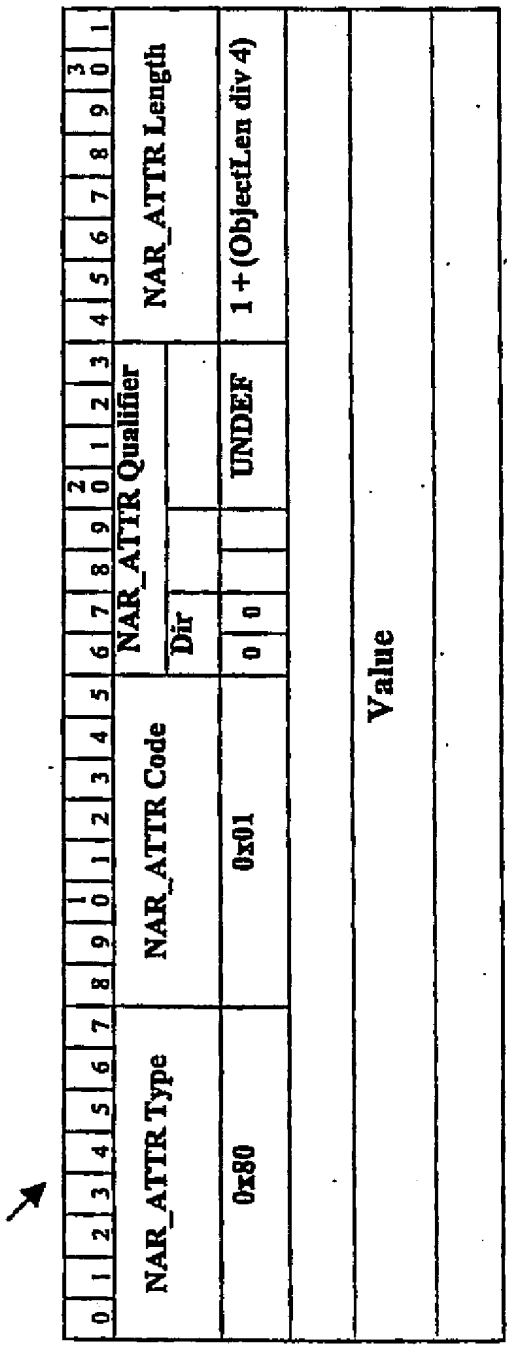
0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 20 1 2 3 4 5 6 7 8 9 30 1
NAR_ATTR Type
NAR_ATTR Code
NAR_ATTR Qualifier
NAR_ATTR Length
0x80
0x01
Dir
0
0
UNDEF
1 + (ObjectLen div 4)
Value

FIG. 13B

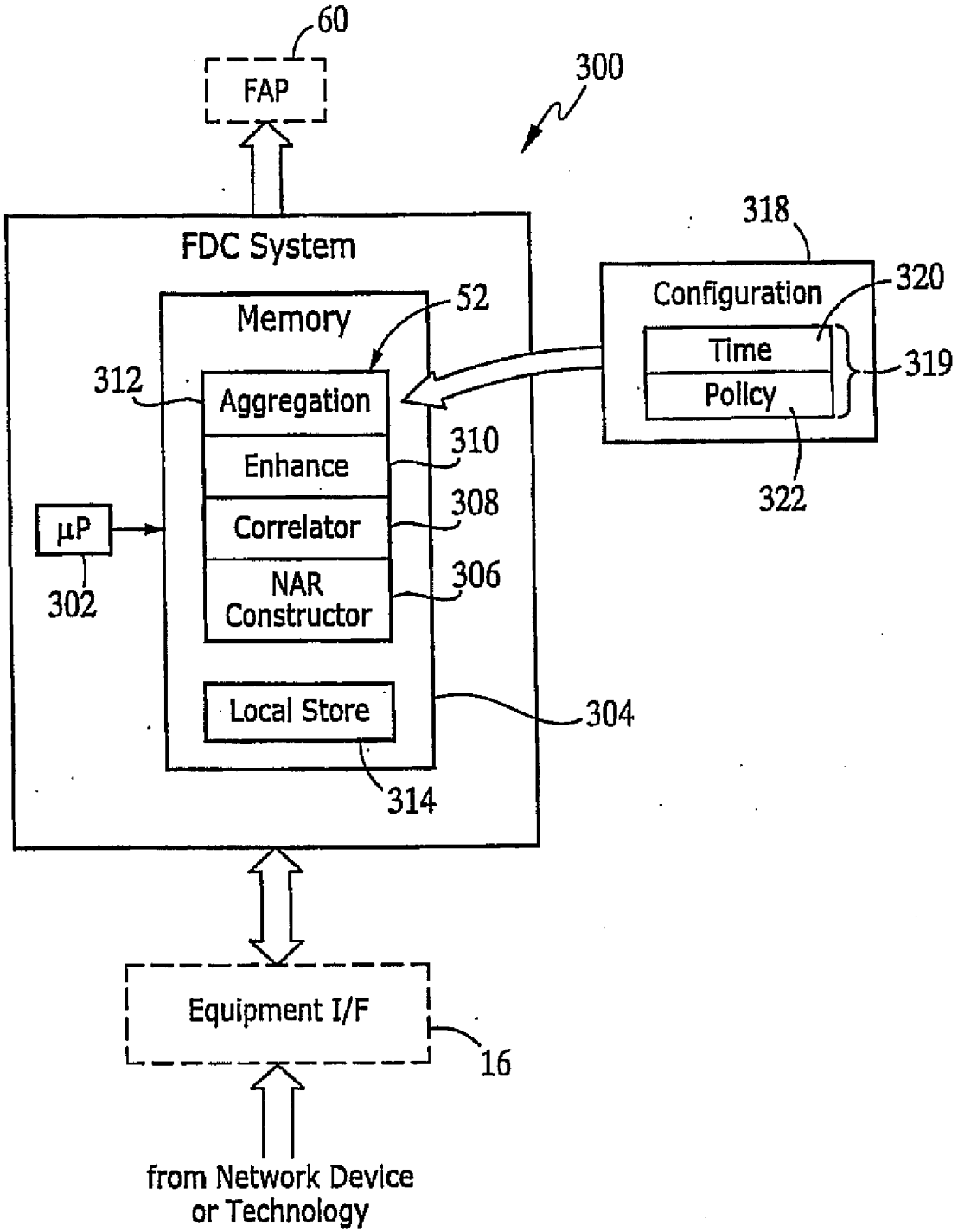
60
FAP
300
FDC System
318
Configuration
320
Time
Policy
319
322
Memory
52
312
Aggregation
Enhance
Correlator
NAR Constructor
310
308
306
μP
302
Local Store
304
314
Equipment I/F
16
from Network Device or Technology

FIG.14

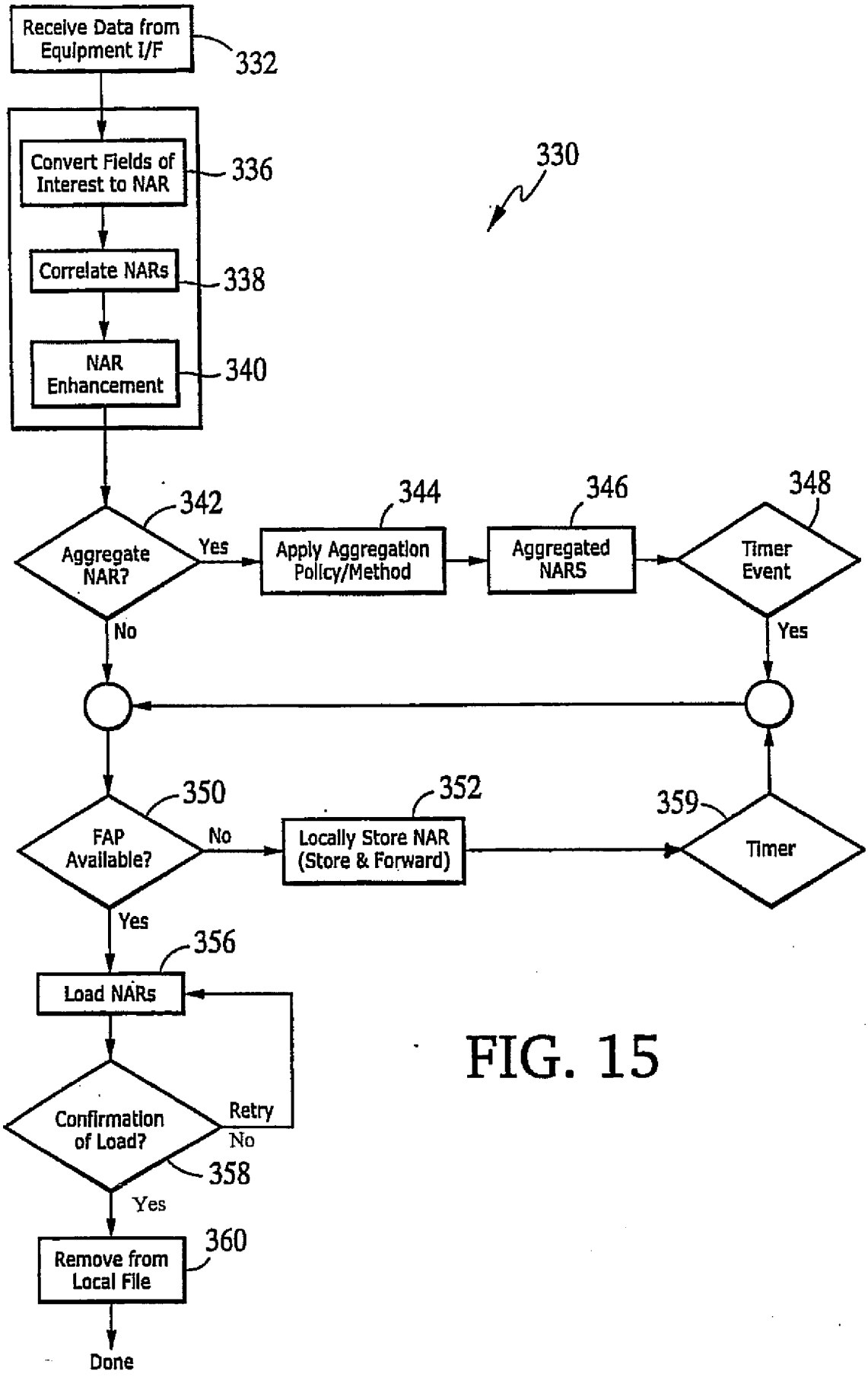
Receive Data from Equipment I/F
332
330
Convert Fields of Interest to NAR
336
Correlate NARs
338
NAR Enhancement
340
342
Aggregate NAR?
Yes
344
Apply Aggregation Policy/Method
346
Aggregated NARS
348
Timer Event
No
Yes
350
FAP Available?
No
352
Locally Store NAR (Store & Forward)
359
Timer
Yes
356
Load NARs
Confirmation of Load?
Retry
No
358
Yes
360
Remove from Local File
Done

FIG. 15

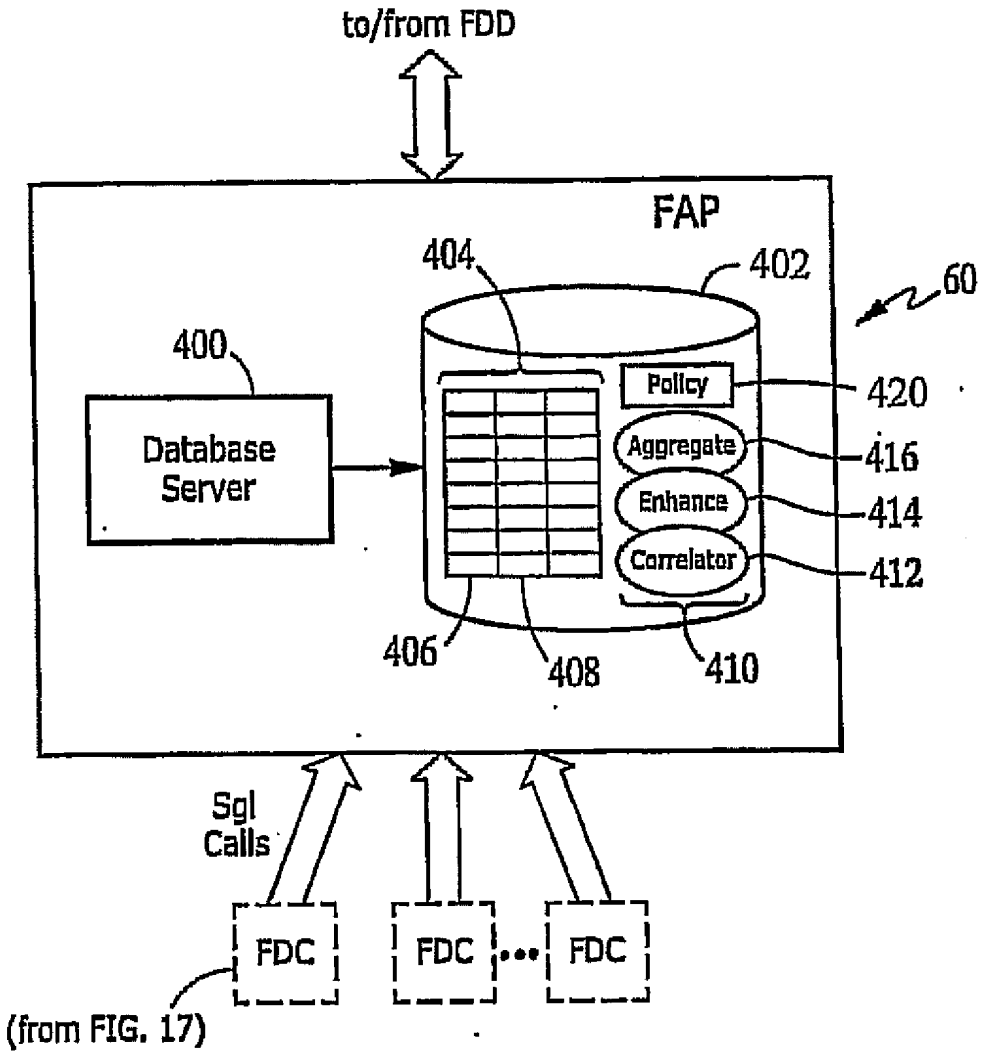
to/from FDD
FAP
404
402
60
400
Database Server
Policy
420
Aggregate
416
Enhance
414
Correlator
412
406
408
410
Sql Calls
FDC
FDC
FDC
(from FIG. 17)

FIG. 16

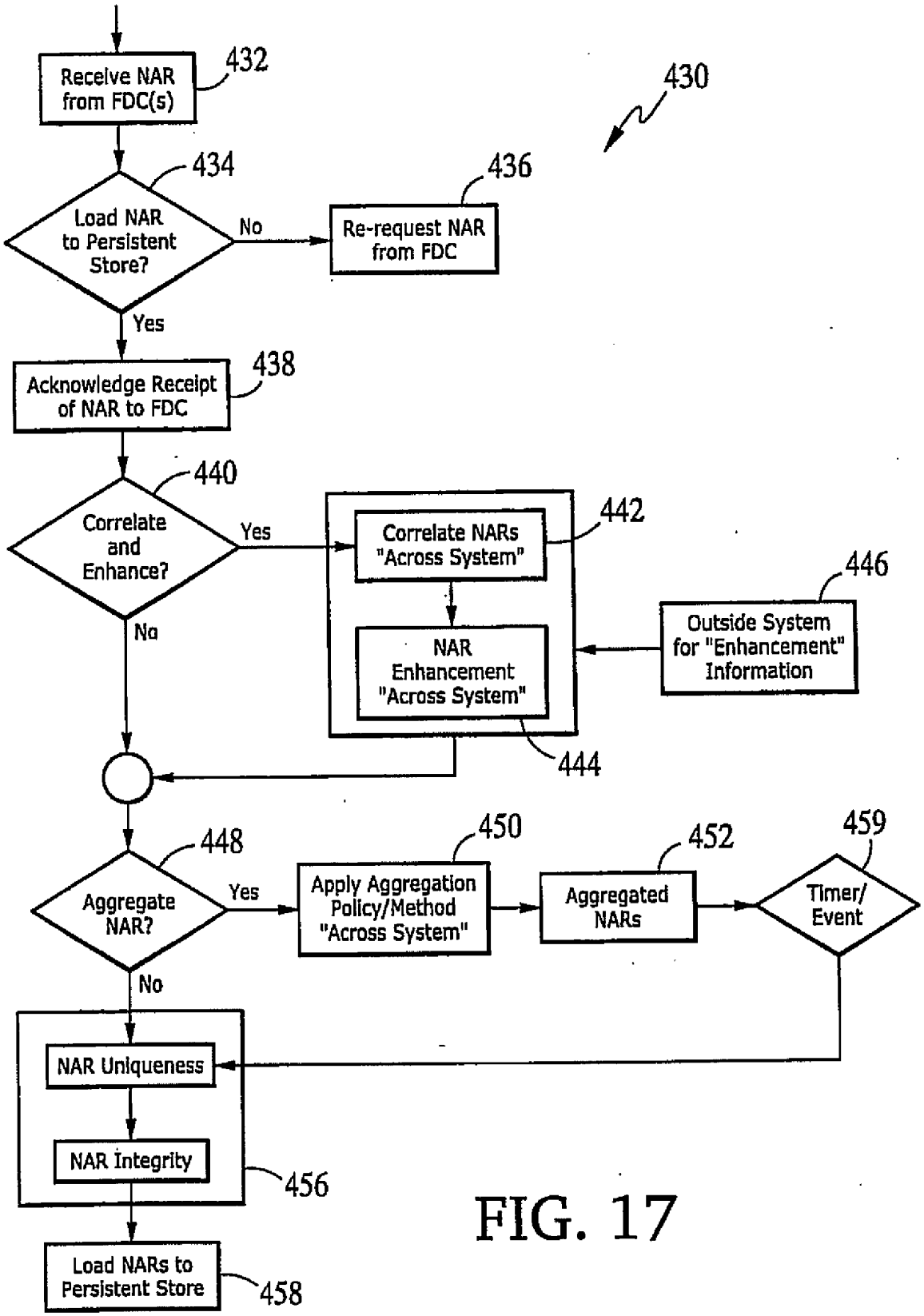
Receive NAR from FDC(s)
432
430
Load NAR to Persistent Store?
434
No
Re-request NAR from FDC
436
Yes
Acknowledge Receipt of NAR to FDC
438
Correlate and Enhance?
440
Yes
Correlate NARs "Across System"
442
NAR Enhancement "Across System"
Outside System for "Enhancement" Information
446
444
No
Aggregate NAR?
448
Yes
Apply Aggregation Policy/Method "Across System"
450
Aggregated NARs
452
Timer/ Event
459
No
NAR Uniqueness
NAR Integrity
456
Load NARs to Persistent Store
458

FIG. 17

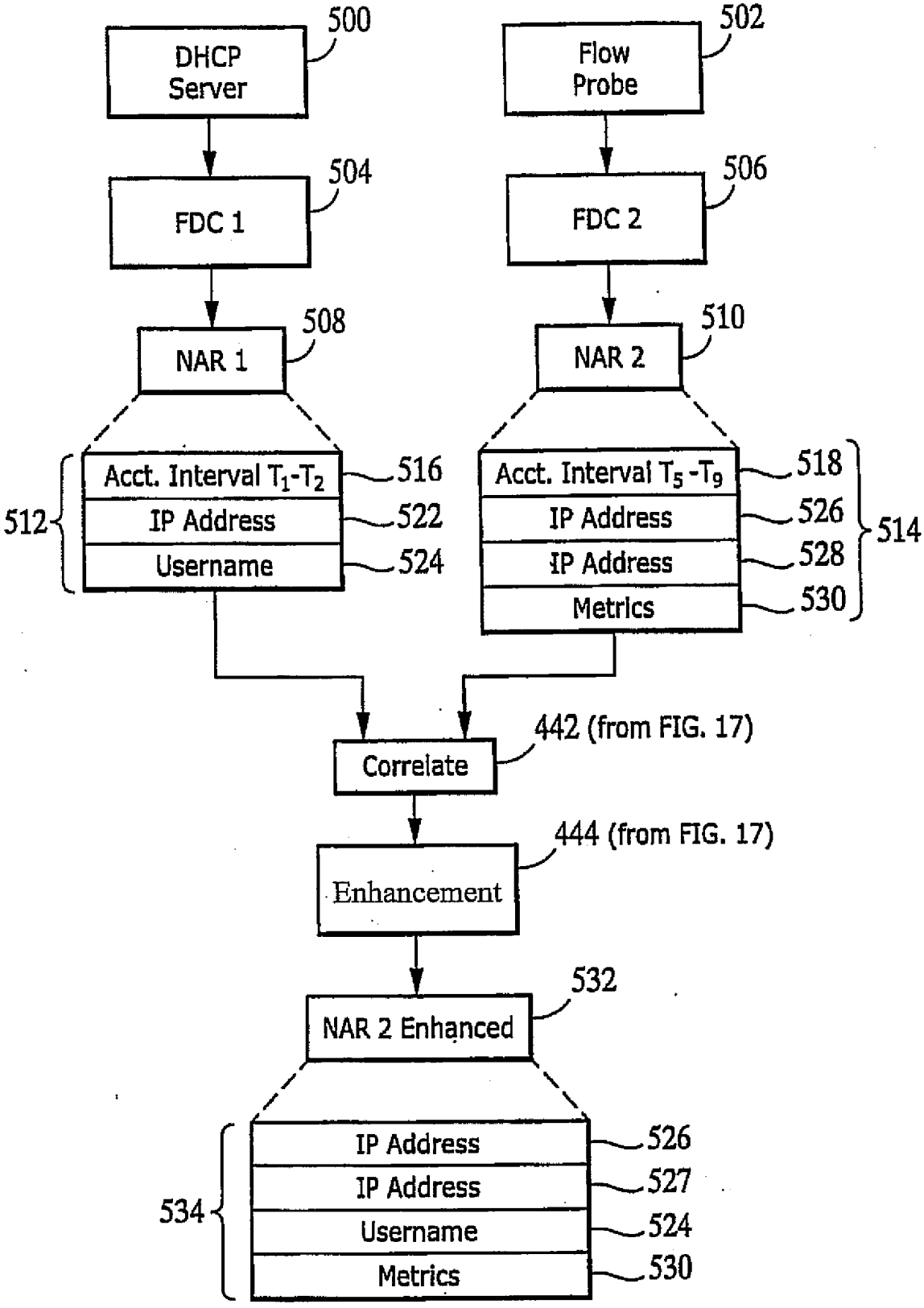
DHCP Server
500
Flow Probe
502
FDC 1
504
FDC 2
506
NAR 1
508
NAR 2
510
Acct. Interval T_1-T_2
516
IP Address
522
Username
524
512
Acct. Interval T_5 -T_9
518
IP Address
526
IP Address
528
Metrics
530
514
Correlate
442 (from FIG. 17)
Enhancement
444 (from FIG. 17)
NAR 2 Enhanced
532
IP Address
526
IP Address
527
Username
524
Metrics
530
534

FIG. 18

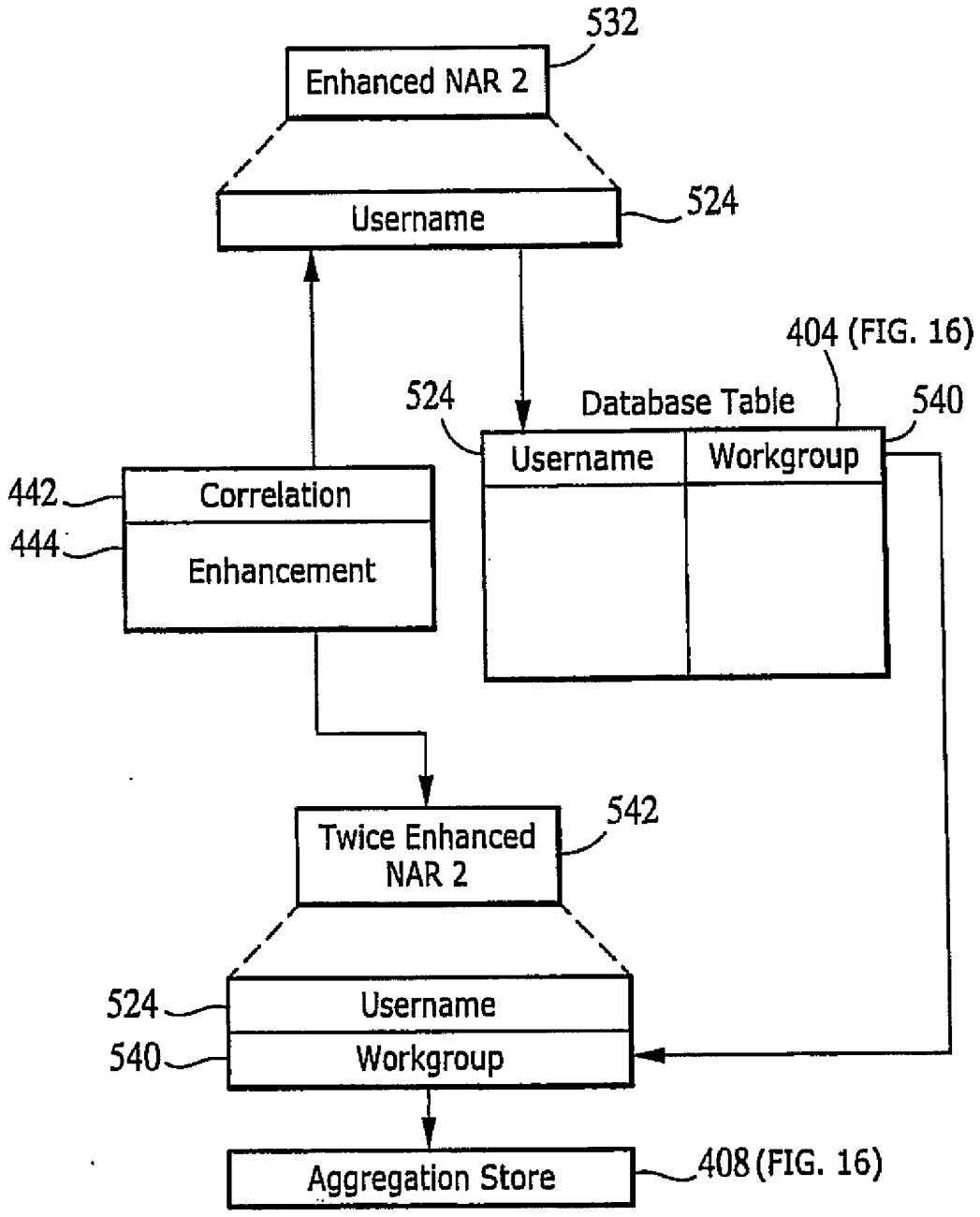
532
Enhanced NAR 2
Username
524
404 (FIG. 16)
524
Database Table
540
Username
Workgroup
442
Correlation
444
Enhancement
542
Twice Enhanced NAR 2
524
Username
540
Workgroup
Aggregation Store
408 (FIG. 16)

FIG. 19

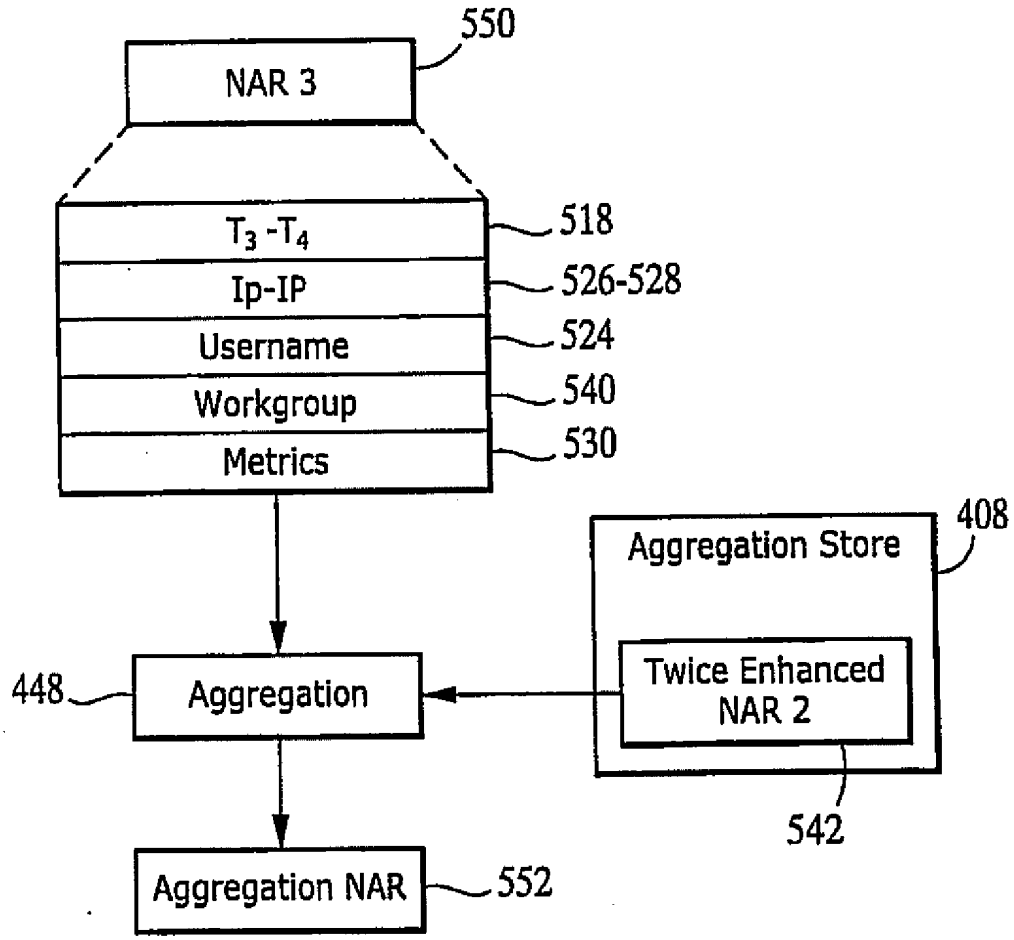
550
NAR 3
T_3 -T_4
518
Ip-IP
526-528
Username
524
Workgroup
540
Metrics
530
408
Aggregation Store
Twice Enhanced NAR 2
542
448
Aggregation
Aggregation NAR
552

FIG. 20

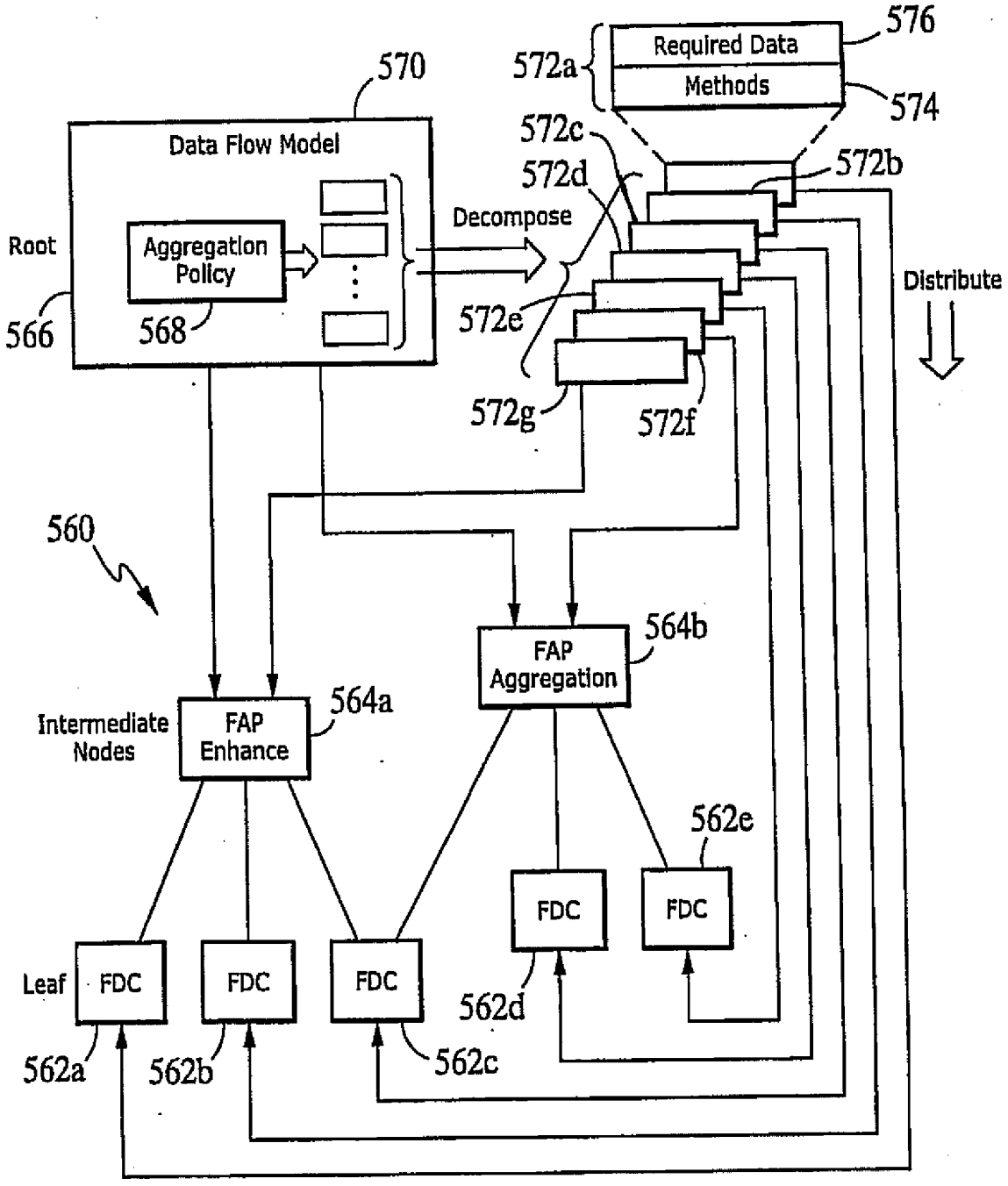
Required Data
Methods
576
572a
574
570
Data Flow Model
572c
572d
572b
Root
Aggregation Policy
Decompose
Distribute
566
568
572e
572g
572f
560
564b
FAP Aggregation
Intermediate Nodes
FAP Enhance
564a
562e
FDC
FDC
Leaf
FDC
FDC
FDC
562d
562a
562b
562c

FIG. 21

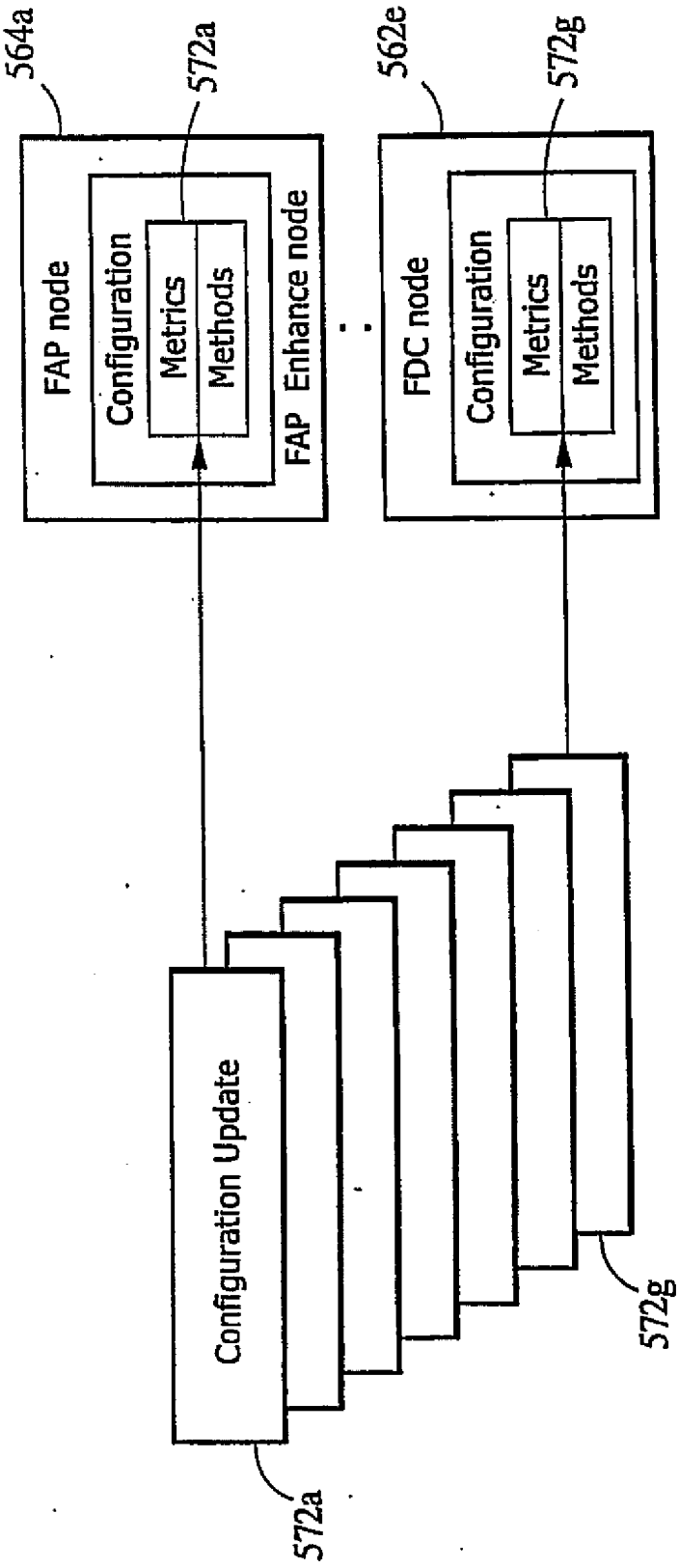
564a
572a
562e
572g
FAP node
Configuration
Metrics
Methods
FAP Enhance node
FDC node
Configuration
Metrics
Methods
Configuration Update
572a
572g

FIG. 22

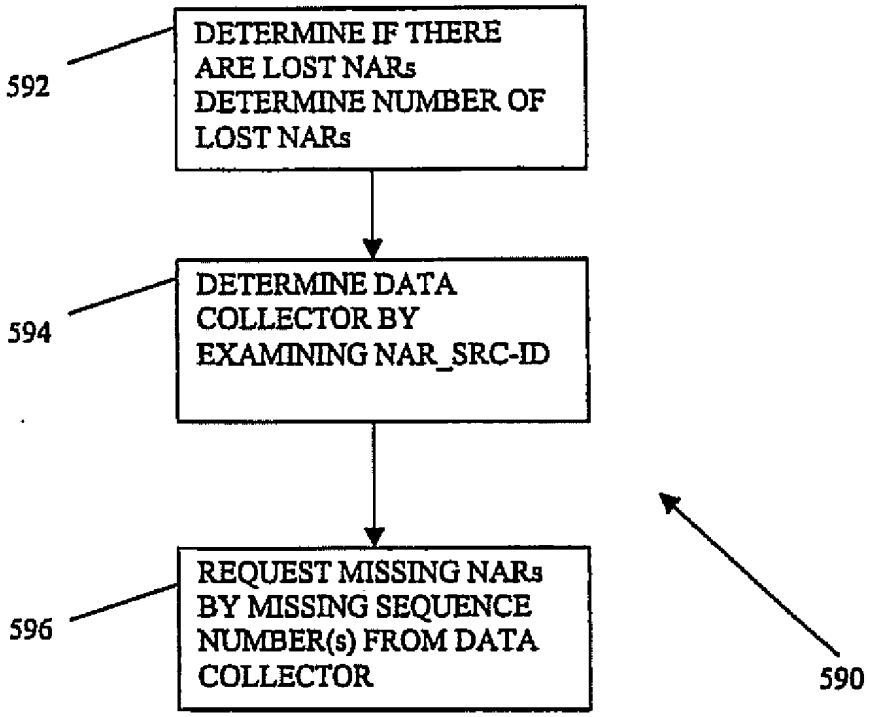
DETERMINE IF THERE ARE LOST NARs DETERMINE NUMBER OF LOST NARs
592
DETERMINE DATA COLLECTOR BY EXAMINING NAR_SRC-ID
594
REQUEST MISSING NARs BY MISSING SEQUENCE NUMBER(s) FROM DATA COLLECTOR
596
590

FIG. 23

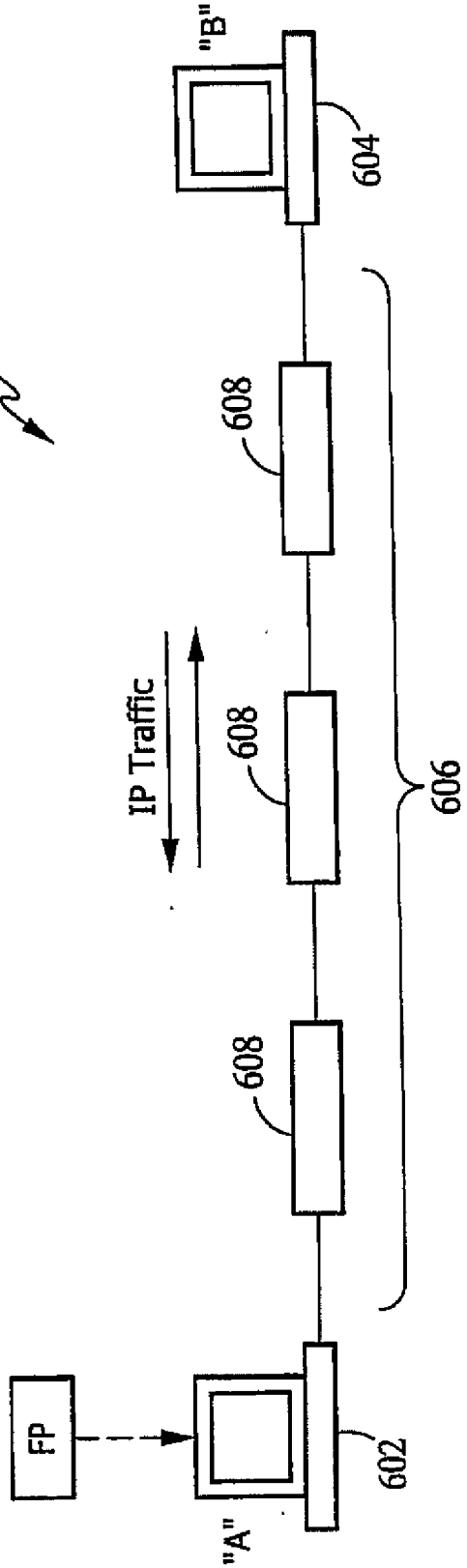

FIG. 24

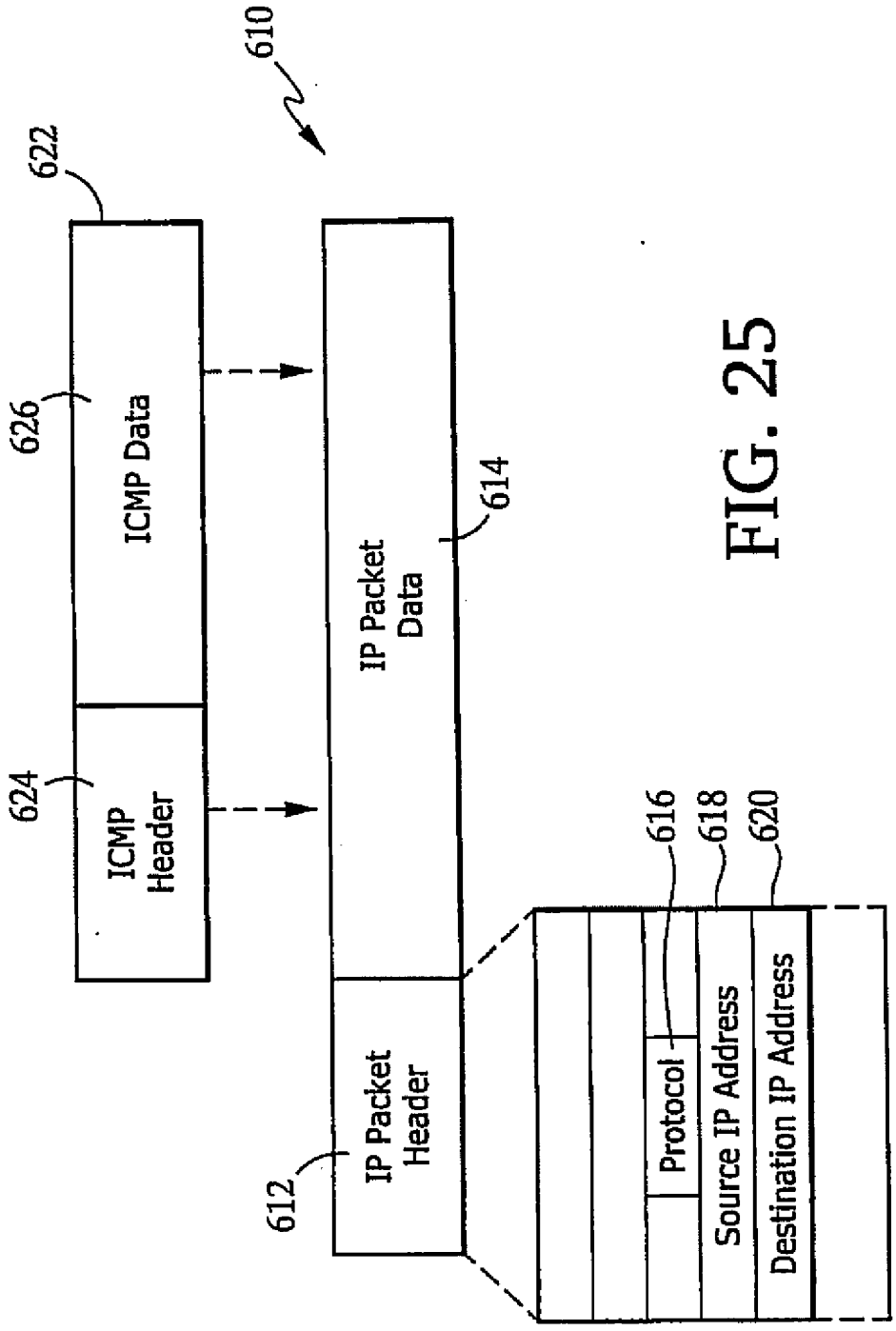
610
622
626
ICMP Data
624
ICMP Header
IP Packet Data
614
612
IP Packet Header
616
618
620
Protocol
Source IP Address
Destination IP Address

FIG. 25

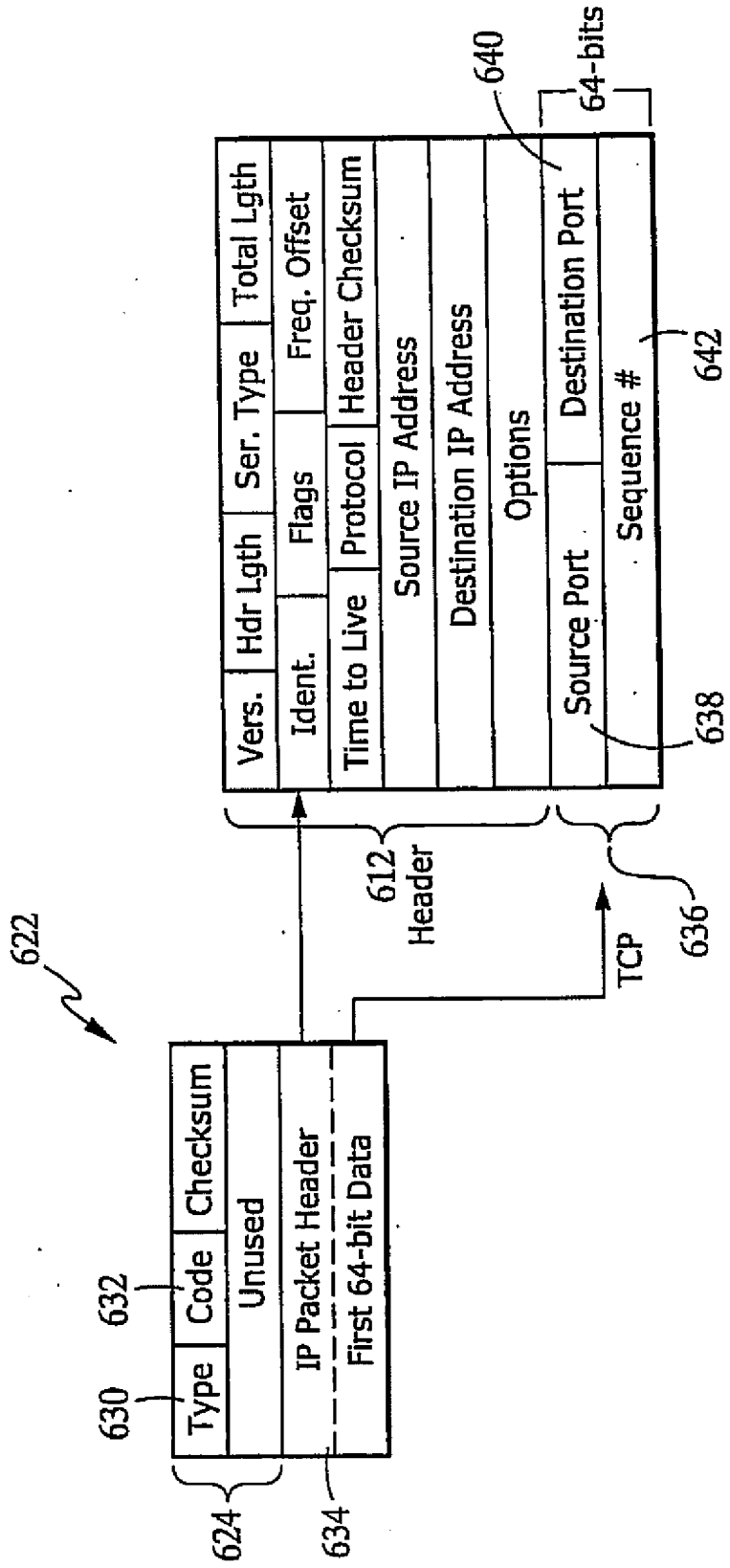
622
630
632
Type
Code
Checksum
Unused
IP Packet Header
First 64-bit Data
624
634
612
Header
TCP
636
638
640
642
64-bits
Vers.
Hdr Lgth
Ser. Type
Total Lgth
Ident.
Flags
Freq. Offset
Time to Live
Protocol
Header Checksum
Source IP Address
Destination IP Address
Options
Source Port
Destination Port
Sequence #

FIG. 26

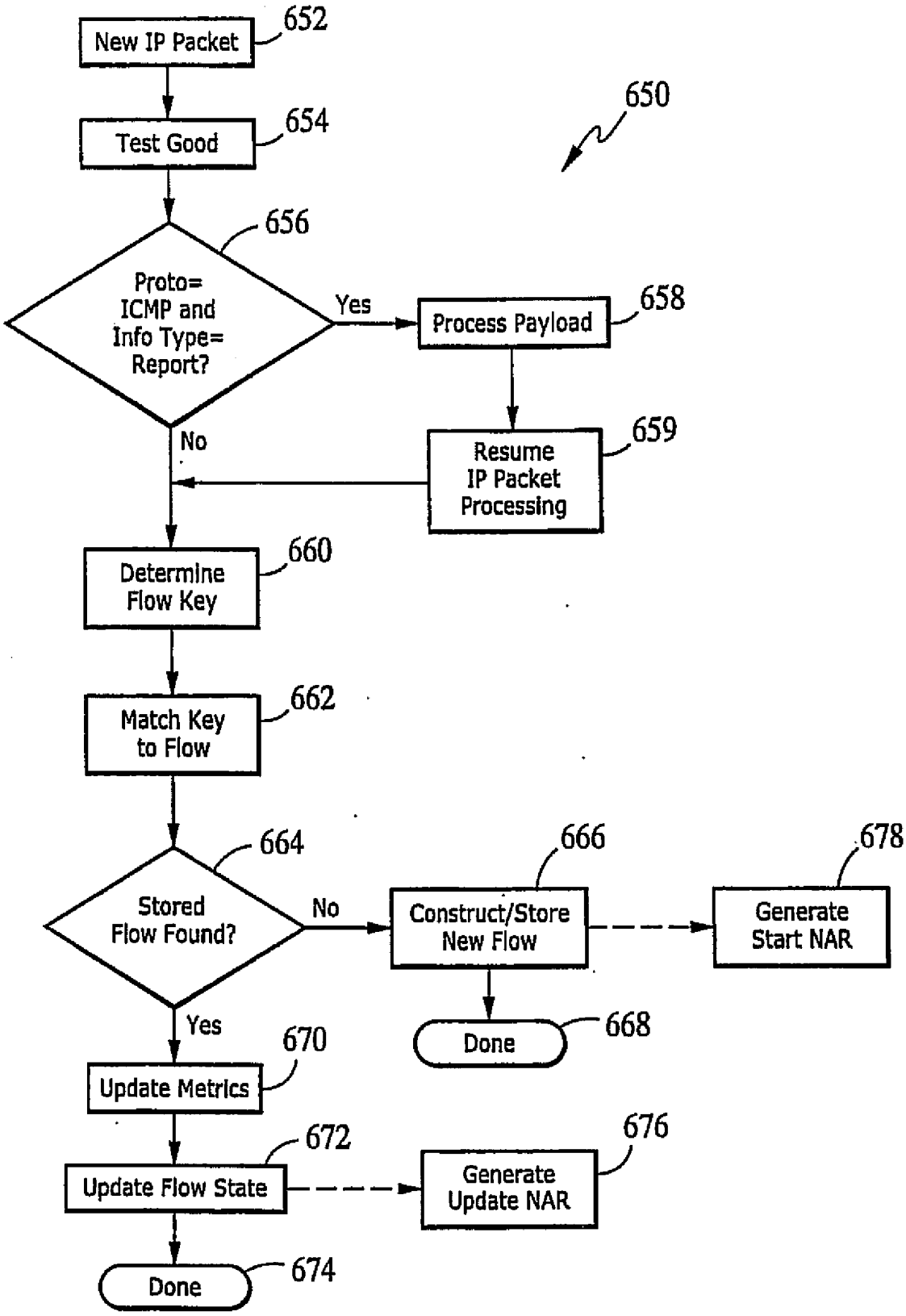
New IP Packet
652
650
Test Good
654
Proto= ICMP and Info Type= Report?
656
Yes
Process Payload
658
No
Resume IP Packet Processing
659
Determine Flow Key
660
Match Key to Flow
662
Stored Flow Found?
664
No
Construct/Store New Flow
666
Generate Start NAR
678
Yes
Done
668
Update Metrics
670
Update Flow State
672
Generate Update NAR
676
Done
674

FIG. 27

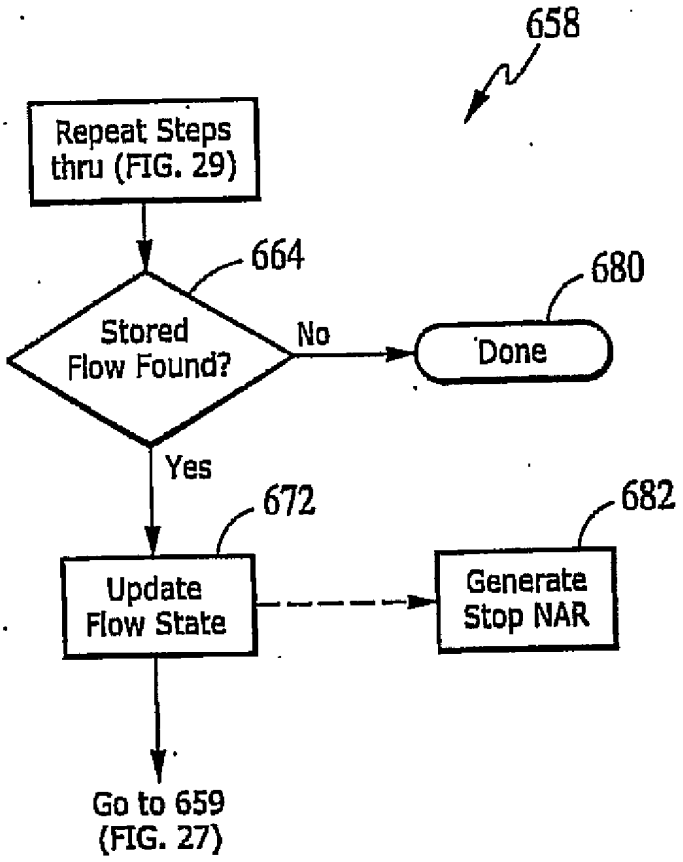
658
Repeat Steps thru (FIG. 29)
664
Stored Flow Found?
No
680
Done
Yes
672
Update Flow State
682
Generate Stop NAR
Go to 659 (FIG. 27)

FIG. 28

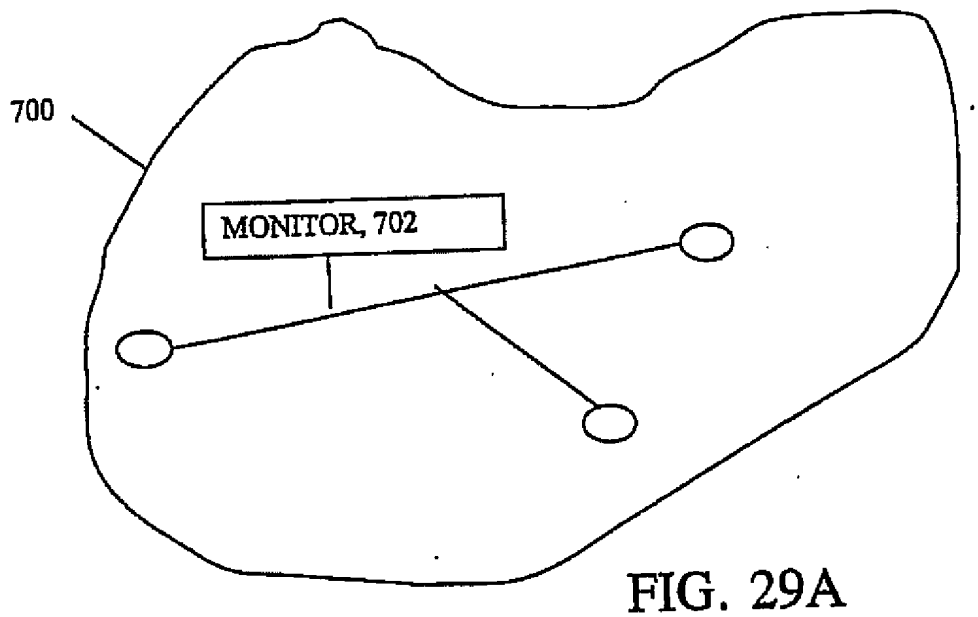

FIG. 29A

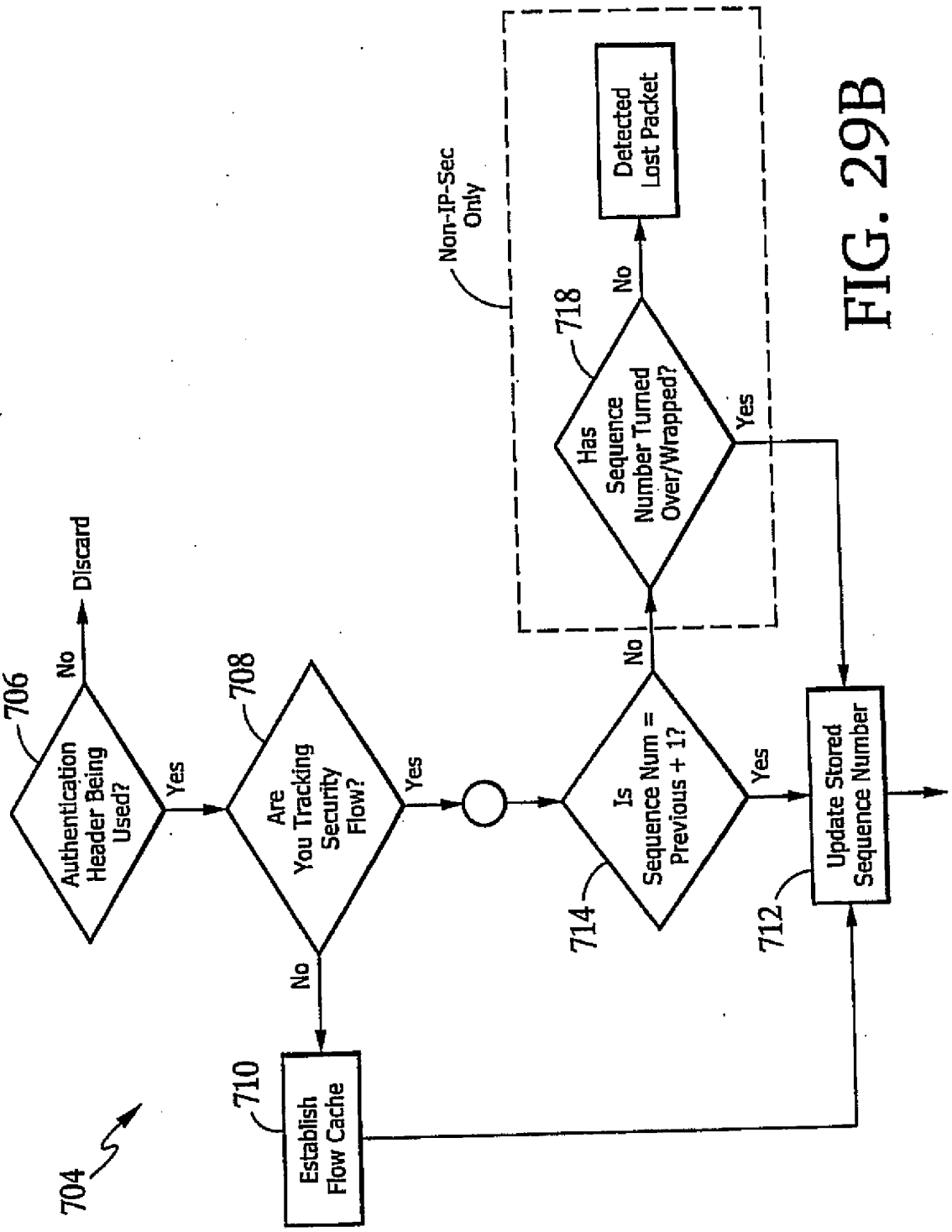
704
706
Authentication Header Being Used?
No
Discard
Yes
708
Are You Tracking Security Flow?
Yes
No
710
Establish Flow Cache
Non-IP-Sec Only
714
Is Sequence Num = Previous + 1?
No
718
Has Sequence Number Turned Over/Wrapped?
No
Detected Lost Packet
Yes
Yes
712
Update Stored Sequence Number

FIG. 29B

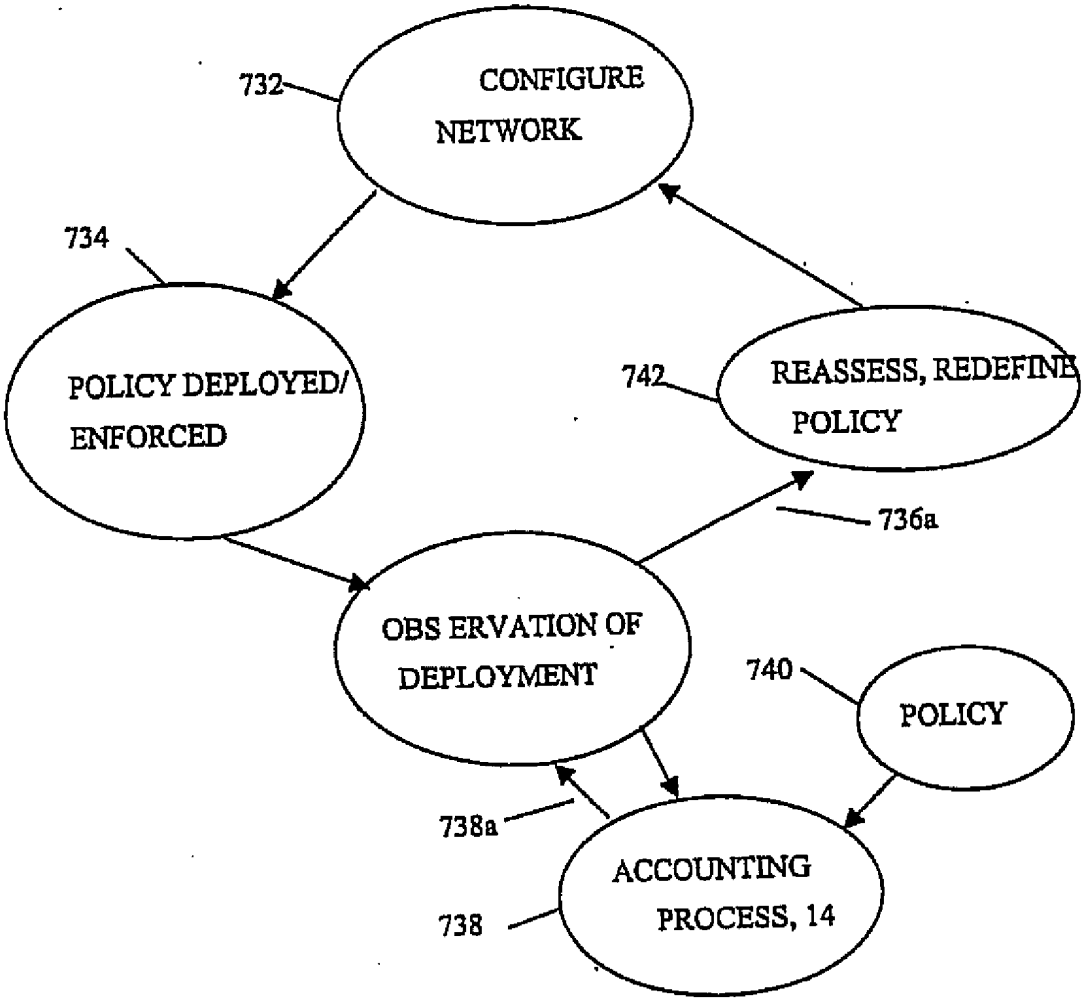
732
CONFIGURE NETWORK
734
POLICY DEPLOYED/ ENFORCED
742
REASSESS, REDEFINE POLICY
736a
OBS ERVATION OF DEPLOYMENT
740
POLICY
738a
ACCOUNTING PROCESS, 14
738

FIG. 30

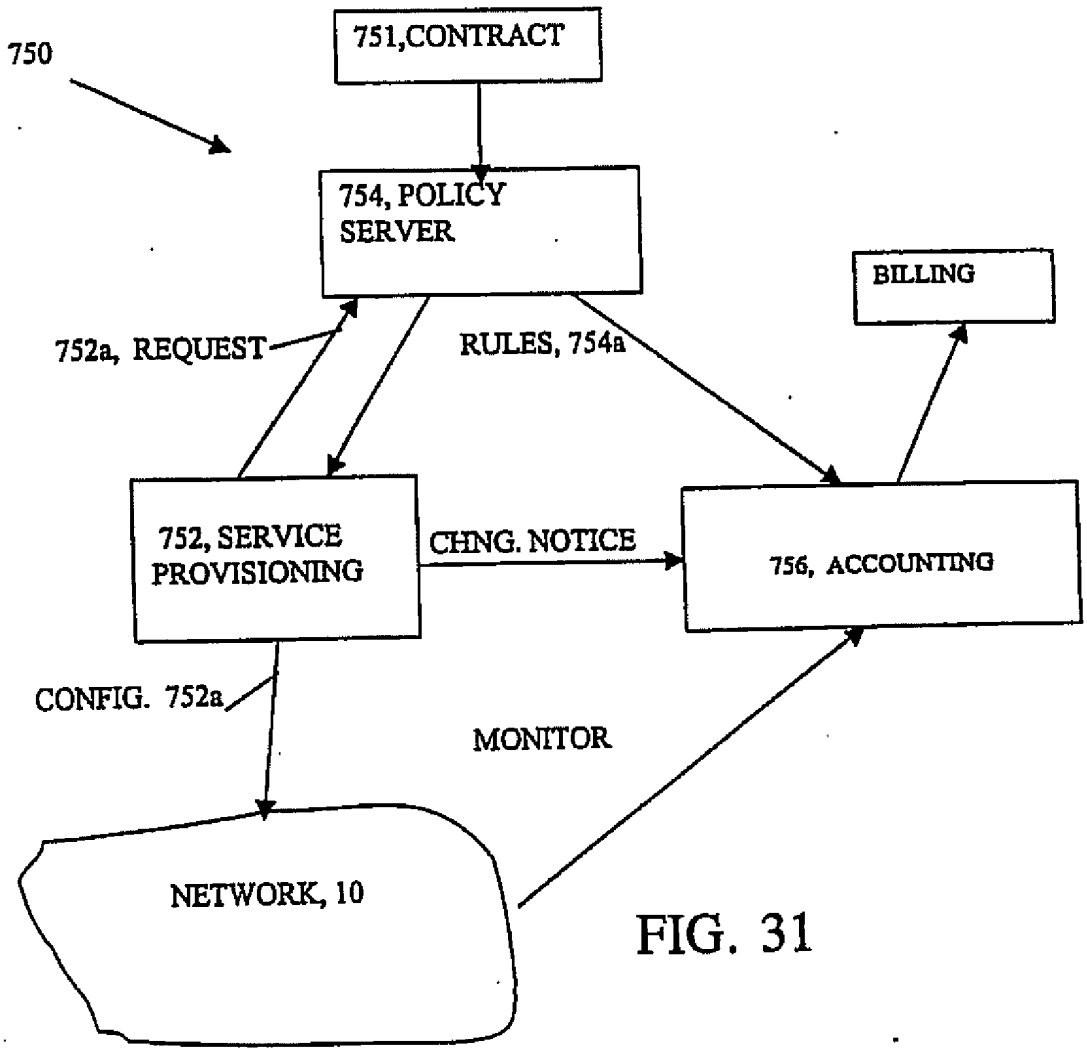
750
751,CONTRACT
754, POLICY SERVER
BILLING
752a, REQUEST
RULES, 754a
752, SERVICE PROVISIONING
CHNG. NOTICE
756, ACCOUNTING
CONFIG. 752a
MONITOR
NETWORK, 10

FIG. 31

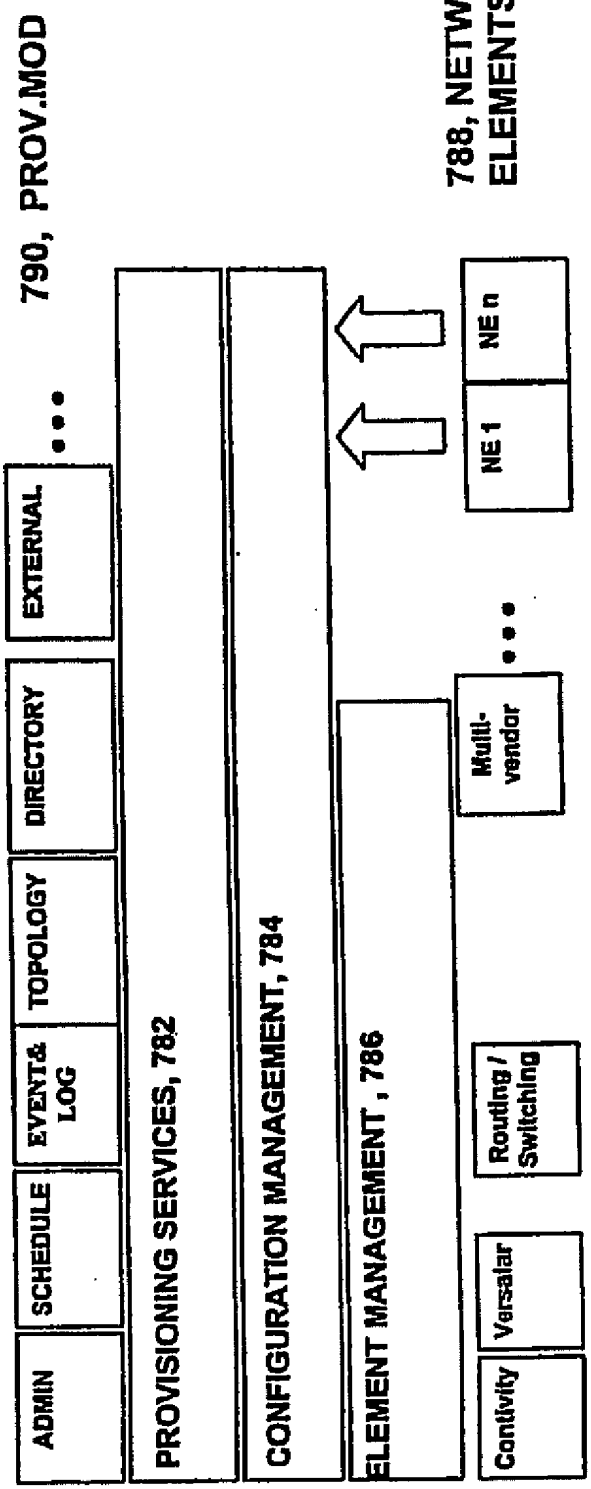
790, PROV.MOD
788, NETWORK ELEMENTS
ADMIN
SCHEDULE
EVENT& LOG
TOPOLOGY
DIRECTORY
EXTERNAL
PROVISIONING SERVICES, 782
CONFIGURATION MANAGEMENT, 784
ELEMENT MANAGEMENT , 786
Contivity
Versalar
Routing / Switching
Multi-vendor
NE 1
NE n

FIG. 32